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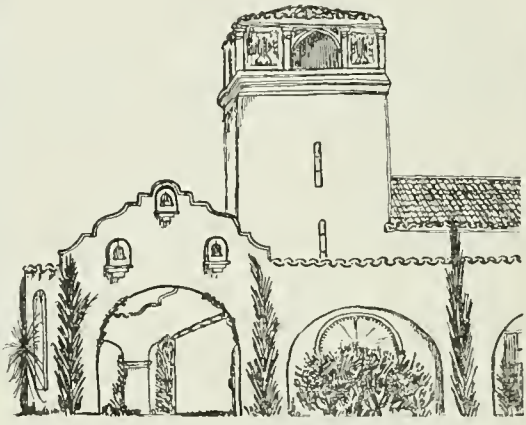

COLLEGE OF OSTEOPATHIC PHYSICIANS
AND SURGEONS · LOS ANGELES, CALIFORNIA

URGENT SURGERY

URGENT SURGERY

BY

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VOL. II.

THE GENITO-URINARY ORGANS—THE RECTUM AND ANUS—THE STRANGULATED HERNIAS—THE EXTREMITIES

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URGENT SURGERY.

VOLUME II.

SECTION VII.—GENITO-URINARY ORGANS.

COLPOTOMY.

IN certain *retro-uterine purulent accumulations* immediate evacuation by the vaginal route is a very useful and, at the same time, very simple procedure.

Of course the urgency in these conditions is not comparable with that of a strangulated hernia, nor with the cataclysmic hæmorrhages which we have previously considered. Still, the operation is not less necessary, and as it is very desirable that it should be done well and quickly, it requires our consideration.

CASE I.—A woman, 44 years of age, was brought to us at La Pitié, in September, 1892. For five weeks she had been suffering from abdominal pains, radiating into the iliac regions and loins, which had compelled her to give up work and take to bed; since then, however, in spite of treatment, the pains had increased, and the condition had been aggravated by the development of constipation, abdominal distention, and occasional vomiting. She was pale, her features somewhat pinched, and the temperature ranged between 101° and 102°.

The abdomen was soft, however, at least in the greater part of its extent, though somewhat tense and resistant in the hypogastric and left iliac regions. On vaginal examination, the cervix was found to be pushed strongly forwards and to the right; behind and to the left it was surrounded by a large and extremely tender swelling, soft rather than fluctuant: rectal palpation showed quite plainly that *the mass occupied the whole of Douglas' pouch*, and on bimanual examination, fluctuation was very definitely obtained between the hand placed on the abdomen and the finger in the vagina or rectum.

The mucous lining of the vagina was swollen and œdematous, and on direct inspection, with the aid of a speculum, the mucosa of the posterior and left lateral fornices appeared as a reddish swelling, not unlike, apart from differences in size, the swelling of the gums seen in cases of dental periostitis.

A large retro-uterine abscess, bulging into, and accessible by, the vagina, was the quite evident diagnosis. I made a preliminary puncture with an aspirating trocar (I should not do that now, but it was my first colpotomy) and withdrew some pus: then I incised the posterior fornix, transversely, at the centre of the reddish swelling just mentioned; I opened, almost at once, into an

abscess from which at least a pint of pus escaped, and my finger entered a huge retro-uterine cavity, the bottom of which I could not reach; after free irrigation with sublimate solution, I placed a mesh of iodoform gauze in the incision (nowadays I always use a drainage tube: we shall see why immediately), and packed the vagina lightly. The fever subsided at once, and the patient recovered without the slightest complication. Twenty-eight days later she was discharged from hospital.

Case 2.—A woman, 33 years of age, had suddenly been attacked eight days previously with severe pains, which she likened to colic; the pains became more and more acute, and were situated particularly in the right side of the abdomen. The temperature varied from 101° to 102°; in the lower part of the abdomen, on the right side, a tender infiltrated thickening could be felt extending into the pelvis.

The vulva and vagina were œdematous; behind the cervix, which was displaced forwards, and could only be recognized with difficulty behind the pubis, a large, indefinitely-rounded mass could be felt, projecting under the layer of œdematous tissue, fluctuating, although very tense and extremely tender.

Posterior colpotomy was performed: I evacuated a large quantity of grumous fœtid pus, and penetrated into an irregular cavity, at the bottom of which I thought I could feel the sinuous outline of a thickened tube. After irrigation with boiled water, a large drainage tube was placed in the cavity, and the vagina packed with gauze. The patient left hospital, cured, twenty days later. She has since been seen by my friend and former student, Dr. Fonvielle[1]: she is in good health and working.

The following case deserves special mention, in that an enormous retro-uterine abscess, which had developed without fever and without inflammatory reaction *first attracted attention by causing retention of urine, and indeed only indicated its existence by signs of compression.*

Case 3.—The patient was a woman, some 60 years of age, who had previously always enjoyed good health, and who had for three days been unable to pass urine spontaneously. The medical man who had been called to see her had, with some difficulty, emptied the bladder by means of the catheter, and had discovered a large tumour filling the vagina. On separating the very œdematous lips of the vulva, the posterior wall of the vagina was seen to be raised up into a prominent rounded swelling; on following this swelling upwards with the finger, it was found to occupy the entire posterior vaginal wall, and above, it filled and distended the pouch of Douglas; the cervix could not be reached, the bladder was pushed far forwards, and a catheter, to enter the organ, had to be passed almost vertically upwards. The large mass could only be detected with difficulty by abdominal palpation, because of the thickness of the wall; but was manifestly fluctuating. I incised it by the vagina: more than two pints of brownish, odourless pus escaped; as the cavity emptied, the uterus descended and resumed its normal position; the same evening the patient passed urine naturally. She made a rapid recovery.

We have, therefore, a first group of very definite indications: **a retro-uterine abscess bulging into the posterior fornix, associated with acute pain, some fever, and sometimes with œdema of the vagina and vulva.** The route to be adopted for the purpose of opening the abscess is indicated by the situation which the accumulation occupies, and

[1] A. Fonvielle, *Considérations sur le traitement des suppurations et des hématocèles pelviennes par la colpotomie postérieure, suivie de drainage.* Thèse de doct., 1898, No. 106.

by the swelling which shows itself behind the cervix. Whatever the point of departure of the abscess may be, whether it has originated in a diseased tube, from an old-standing abscess in the broad ligament, from a suppurating ovarian cyst, or is due to suppuration occurring in a pelvic hæmatocele, the treatment remains the same, and as we shall see, a colpotomy in urgent conditions ought, above all, to be a simple operation, consisting in the simple incision of an abscess.[1]

We have just mentioned **suppurating hæmatocele.** As a matter of fact, in cases of pelvic hæmatocele the indications for early operative intervention are usually produced by suppuration and its associated symptoms. Usually it will be possible to obtain a history of a sudden, more or less painful, onset of the trouble, some days or weeks previously, after a period of undoubted amenorrhœa, or at least of menstrual irregularity; commonly a bloody uterine discharge will have persisted since the beginning of the illness, and very often the intra-abdominal lesion—tubal abortion or rupture—has, on a superficial examination, been taken for an ordinary miscarriage. But fever appears, the pains become more acute and lancinating, and associated often with rectal tenesmus and a discharge of glairy mucus; on vaginal examination, a large retro-uterine mass is found bulging into the posterior fornix and pushing the œdematous posterior vaginal wall more or less downwards. At the stage now under consideration, the condition is simply a blood abscess, a suppurating hæmatoma, and nothing more; for that reason, incision and drainage by the vagina constitute the proper line of treatment.

But even in the absence of suppuration some very large tense hæmatoceles, which have been in existence for some time[2] may give rise to pain, signs of compression and peritoneal reactions, and in such cases evacuation by the vaginal route, as soon as possible, constitutes a satisfactory and easy operation within the powers of any practitioner.

Of course this procedure ought to be restricted to the **encysted hæmatoceles which bulge prominently into the vagina,** which, in a sense, present themselves naturally by that channel, and cannot be considered as a method of choice under other circumstances.[3]

Later on we shall study certain **serous accumulations** in the pouch of Douglas, due to pelvic peritonitis, in which simple evacuation through a vaginal incision is followed by rapid disappearance of the symptoms.

[1] Therefore it can only give unsatisfactory results in cases of diffuse pelvic suppuration with multiple pockets of pus, as has been shown by Jean d'Herbecourt in his thesis, "*De la voie vaginale sans hystérectomie, indications, résultats opératoires.*" Thèse de doct., 1900.

[2] On the other hand, the vaginal route is not adapted for the treatment of the recent tuba ruptures with severe hæmorrhage, of which we have already spoken, nor of hæmatoceles with recurring hæmorrhages: to put it shortly, it is not suitable for the treatment of any cases in which the effused blood has not been converted into a definite, well-encysted hæmatoma, from the walls of which bleeding has ceased.

[3] We cannot enter into a discussion of the comparative values of the abdominal and vaginal routes in the treatment of pelvic hæmatoceles, or more precisely, the hæmorrhagic effusions due to rupture of extra-uterine gestations. Here we are speaking only of encysted accumulations of blood in Douglas' pouch, bulging into the vagina, developing definitely in that direction, and displacing the uterus, bladder, and rectum: colpotomy in such cases consists in a simple incision, and may be rendered immediately necessary by the appearance of symptoms of painful compression of the pelvic organs.

Operative Technique of Colpotomy. A uterine vulsellum forceps (*Fig.* 1), a posterior vaginal speculum (*Fig.* 2), a scalpel, long scissors (straight and curved), a pair of vaginal dressing forceps, a T-shaped or an ordinary large-sized drainage tube, and some sterilized gauze for the final packing: this is everything necessary for the performance of a colpotomy.

When the operation consists simply in opening a large prominent accumulation, it can be quite well performed with vulsellum forceps, a scalpel, and a drainage tube; but on the other hand, in the less simple

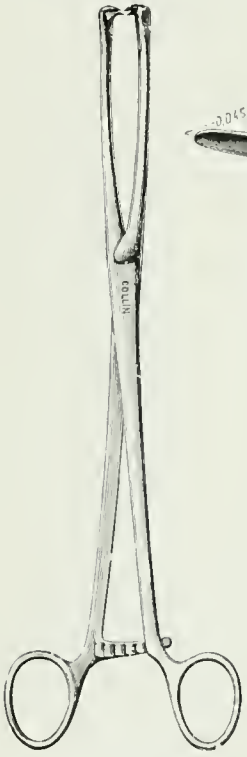


Fig. 1.—Uterine vulsellum forceps.

Fig. 2. Posterior vaginal speculum.

Fig. 3.—Long pressure-forceps.

cases where the fluid does not lie quite so superficially, it will be well to add two or three pairs of long forceps (*Fig.* 3) to the instruments mentioned above. Of course, the irrigator, with its tubing and glass cannula, all properly sterilized, should be ready at hand.

General anæsthesia is advisable: if the operation consists in a simple incision of a pointing abscess, an anæsthetic may be dispensed with, or local anæsthesia by means of cocaine may be sufficient; but, as a general rule, it will be better to give chloroform or ether, as the operation will thereby be greatly facilitated and more satisfactorily performed.

Have the patient placed in the gynæcological position with the thighs well flexed and separated, the loins and the upper part of the trunk a little raised, and the vulvar region at a sufficient height to enable the operator, when seated, to work comfortably in a good light.

The vulva is shaved. Then, the perineum, the upper and internal surfaces of the thighs, and the vagina are washed with soap and water; two fingers covered with gauze, and introduced into the vagina, will scrub the walls of the canal, the fornices, and the cervix. The mechanical cleansing may be completed by gently brushing the vaginal walls with a narrow, long-handled brush, followed by free irrigation with warm boiled water; the external region is bathed with spirit and ether, and finally with boiled water, and then surrounded by four sterile towels. The operation area is now ready.

Introduce the speculum, which will be arrested above by the projecting swelling, and gently depress the posterior vaginal wall; the cervix will then come into view; at any rate, even if it is displaced far forwards, its posterior lip may be sufficiently exposed to allow of it being seized and drawn down a little with the vulsellum forceps.

It is always a good plan to make sure first of all of the cervix, not so much with the object of drawing down the uterus, which indeed is often impossible, but in order to fix it and, with it, to fix the swelling to be opened.

If no speculum is available, or if the displacement of the os prevents it being seen, it may be felt for with two fingers passed into the vagina, and along them the fixation forceps will be conducted.

The swelling, or at least the area in which the incision is to be made, will now be visible. The appearance of the posterior fornix is, however, not always the same. Sometimes a large rounded prominent "boss" presents itself behind the cervix, and descends for a variable distance on the posterior vaginal wall; under the thinned, red mucosa the tense abscess, ready to burst at the least touch with the point of the knife, can be felt very definitely; this is especially the form in which large suppurating hæmatoceles present themselves. At other times the prominence is less evident: the cul-de-sac is flattened out, but there is no bulging, and a thickened and œdematous mucous membrane separates the finger from the deep-seated fluctuating mass.

The operation, simple though it is, demands care in its performance; some easily followed rules will prevent the operator going astray, whatever the type of the lesions may be.

Never attempt to puncture the swelling directly with the knife, even if it is prominent: **incise the mucosa first, transversely from one lateral fornix to the other, close to the base of the cervix** (*Plate I*); do not encroach too much on the lateral regions, where the important vessels are situated; in my opinion, even when the swelling is more prominent laterally, it ought still to be approached from behind through the posterior fornix, since in that way it can be reached with the greatest facility and with the least danger.

Draw the scalpel gently, with its cutting edge directed forwards, from

one end to the other of the incision, and thus divide the remaining thickness of the vaginal wall: push back the posterior lip of the incision, which allows itself to be retracted without difficulty, and the lower pole of the fluctuating swelling will be exposed.

The completion of the operation is now the work of an instant; indeed, in the case of large abscesses and large accumulations of blood in the posterior cul-de-sac, the whole thing is done with two cuts of the knife: the mucosa is incised, the swelling punctured, and the opening enlarged by a movement of the finger.

In dealing with rather more complicated cases it will be useful to define the various stages. Any of the following conditions may be encountered:

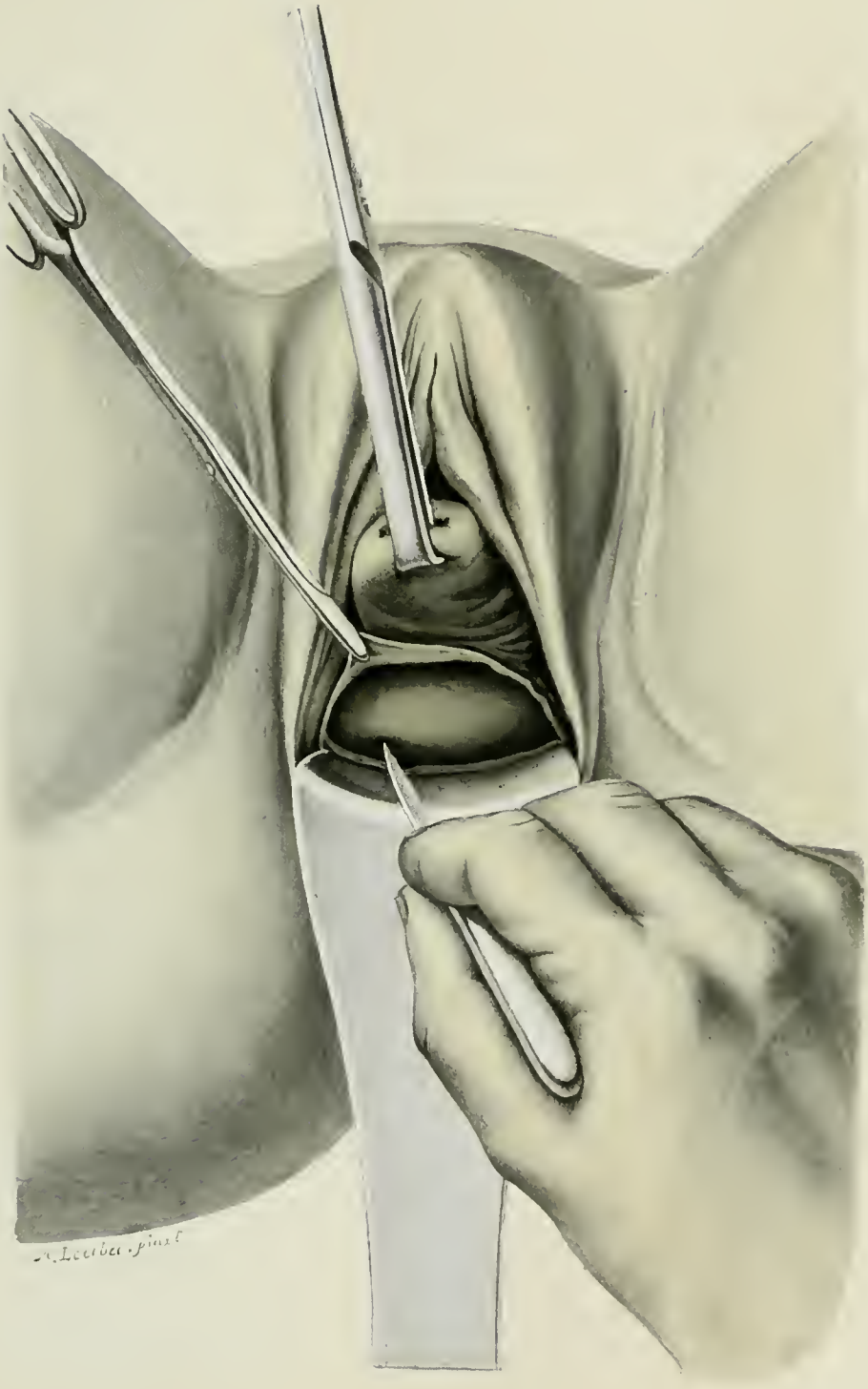
(*A*.) Once the mucosa is incised, **the tense wall, blackish, purple, yellowish, or dirty grey in colour**, of which we have just spoken, is seen (*Fig.* 4): the puncture may be made fearlessly, with the point of the knife directed from behind forwards; or again, a small opening may be made with the points of the scissors; and as soon as the pus and blood begin to escape, the closed blades are passed through the opening and then withdrawn widely open. Allow the stream of fluid to escape, and then, seizing and retracting the posterior edge of the incision with forceps, cleanse the cavity with swabs in holders; if the pus is thick and flows badly, it may be necessary to irrigate the cavity with boiled water; but in that case very little pressure should be employed.

Fig. 4.—Colpotomy: abscess in Douglas' pouch (1st type). Large abscess distending the posterior vaginal wall. (A) Abscess cavity extending up behind the uterus and downwards into the recto-vaginal septum.

In the case of a **hæmatocele**, even when suppurating, the bottom of the cavity is usually occupied by a mass of clot which may need breaking up with the finger before being extracted; caution is always necessary in clearing out blood cysts, and any rough treatment of the inner surfaces of the walls must be avoided, particularly if red blood is seen to be mixed with the clots.[1]

[1] We have had, in common with other operators, to encounter a somewhat alarming diffuse oozing in these cases; in a woman, 34 years of age, after the removal of an enormous mass of clots, a fœtus of about four months, and a large quantity of placental débris, red blood appeared, coming apparently from the extreme upper part of the cavity, and the bleeding was so profuse and persistent, in spite of irrigation with very warm water and compression with tampons, that I prepared to perform laparotomy: however, firm packing ultimately controlled the hæmorrhage, and the patient recovered without further trouble.

Plate I.—**Posterior Colpotomy.** The posterior speculum is in position, the cervix has been seized and drawn forwards, and the vaginal mucosa incised: the abscess is being opened with the scalpel.



POSTERIOR COLPOTOMY

When a **retro-uterine abscess** has been opened, after the evacuation of the pus and irrigation of the cavity, it is always well to make a careful digital examination of the inner surface of the wall for the purpose of discovering and opening up any diverticula or secondary accumulations which may possibly exist.

This measure is not, however, free from danger, and ought to be carried out with caution ; as a matter of fact, once the principal accumulation is emptied the indications are in great part fulfilled. Further, with an abscess situated behind the cervix, the larger the abscess the greater is the likelihood that it is single.

(*B.*) The incision of the posterior fornix is not always so simple as in the cases of large accumulations we have just described. It may happen that when the patient is anæsthetized and prepared, the large mass which had seemed so definite at the top of the vagina, becomes much less evident

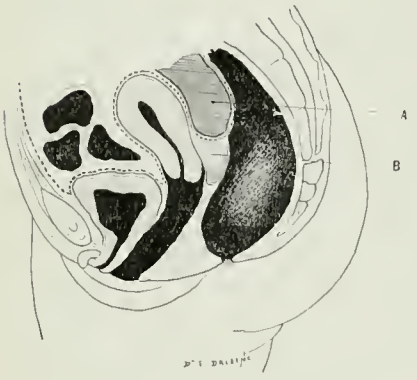


Fig. 5.—Colpotomy : retro-uterine abscess (2nd type). The abscess causes no prominence of the posterior vaginal wall. (A) Collection of pus. (B) Adhesions in the lower part of Douglas' pouch, which must be separated to reach the abscess.

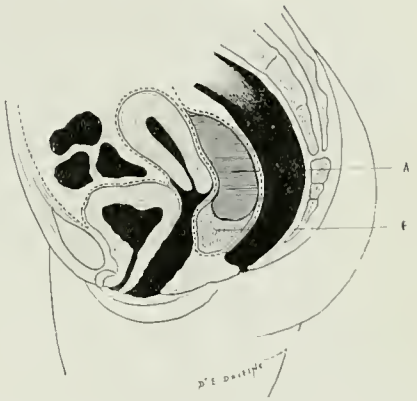


Fig. 6. Colpotomy : superficial accumulation of serous fluid, deep abscess (3rd type). (A) Abscess. (B) Serous accumulation, which is opened first, and at the bottom of which the abscess will be found.

at the time when the incision is about to be made : a thick layer of œdema underlies the vaginal mucosa, sometimes extending down as far as the vulva, and so masking any prominence that the mass appears to have become more deeply situated.

Incise boldly, however, in a transverse direction, behind the base of the cervix as before ; the œdema is itself a fresh and unmistakable proof of the near proximity of the abscess ; incise the vaginal wall close to the posterior aspect of the cervix, and **continue the separation with the finger, never leaving the posterior surface of the uterus,** which will form the best guide, and will conduct the surgeon surely and without danger to the pus.

On several occasions I have worked upwards in this manner for a distance of an inch or an inch and a half—the distance always seems greater than it actually is (*Fig.* 5) : make a way along, and close to, the cervix,

separating and pushing aside the infiltrated tissues with the tip of the finger, or with the closed ends of a pair of long forceps working on the finger ; do not trouble about the somewhat free bleeding from the vaginal incision ; once the existence of the abscess has been settled beforehand, it will certainly be reached by this method.

(*C.*) There is another possible condition, emphasized by M. Monod, and which many surgeons have met with. **A colpotomy is performed, in the expectation of finding pus** ; the posterior cul-de-sac is incised, and, to the operator's surprise, it is *clear serous fluid*, sometimes in very considerable quantity, which is seen to escape from the wound (*Fig.* 6).

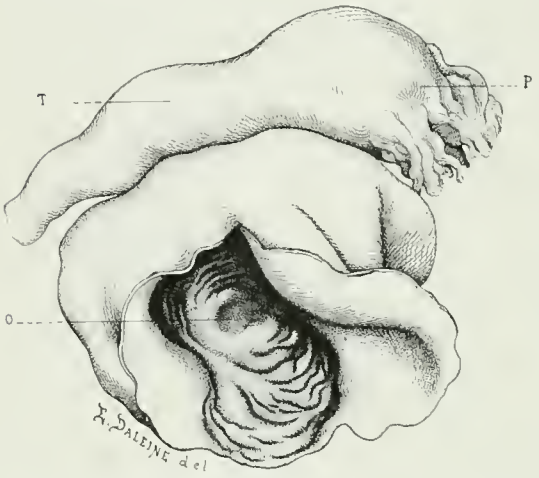


Fig. 7.—Ovarian abscess cavity. (P) Tube thickened and dilated, but comparatively little affected. (O) Ovary transformed into a suppurating cyst.

The serous fluid is not alone, however ; it is due to, and indicates the existence of, *a secondary pelvi-peritonitis* ; higher up in the wall of the cavity which has just been opened, **a second pocket containing pus** will be found, a pyosalpinx, an ovarian abscess (*Fig.* 7), the primary lesion and the initial cause of the trouble. For instance :—

Case 4. — A young woman, some 30 years of age, had suffered for six years with a right-sided salpingo-ovaritis, with occasional painful exacerbations. A fresh and more acute crisis supervened, the temperature rose each night to 101°, 102°, 103°, the pulse was rapid, the abdomen a little distended, although the tenderness was limited to the hypogastric region, particularly on the right side. A vaginal examination showed very definitely that Douglas' pouch was filled by a thick, soft, pseudo-fluctuating mass, which extended into the right lateral region, surrounding the corresponding side of the uterus, and was very painful on the slightest pressure : the uterus was fixed, although on the left side nothing beyond a moderate degree of infiltration could be detected.

After a week in bed, and in spite of treatment (hot vaginal douches, iced applications to the abdomen, milk diet, aperients), the local condition had become worse : the abdomen was, however, soft and painless, there was no evidence of extension of the inflammatory process in that direction ; but behind the cervix the swelling had become more prominent and evidently fluctuating, while the persisting fever confirmed the existence of pus.

Incision of the posterior fornix was indicated, at least as a preliminary operation, the need for which, indeed, presented itself with considerable urgency : it was performed under ether anæsthesia in the ordinary manner. After incising the mucosa transversely, and a thin fibrous layer underlying it, I opened the prominent swelling, which I believed to contain pus, without any difficulty ; however, it was serous fluid, which escaped in considerable quantity, and I penetrated into a cavity with perfectly smooth walls.

This was not enough to account for the symptoms, and on exploring the bottom of this primary focus, I easily recognized a *second pocket*, about the size of an egg, tense, fluctuating, and with a rounded surface : it was adherent in all directions, and appeared to be completely shut off from the general peritoneal cavity. With a pair of long forceps conducted along my finger I succeeded in seizing and tearing its lower wall, thus giving vent to a stream of pus. The inner surface of the cavity was rough, and bled readily ; it was washed out with boiled water and drained.

We had, therefore, met with two different foci in succession : a focus, of **pelvi-peritonitis** full of **serous fluid,** and **a deep suppurating focus** which was simply a large pyosalpinx.

These cases are not uncommon, and their importance is very considerable, since no benefit can be expected from operation if the second pus-containing pocket is not found and emptied in its turn. The evacuation of the second cavity, which must almost always be done on the finger, without any visual guidance, requires all the precautions we have mentioned above.[1]

Another group of cases requires mention, in which, after the serous accumulation filling Douglas' pouch has been evacuated, no deeper-seated, purulent accumulation can be discovered ; the uterine appendages, though undoubtedly diseased, are not the seat of any fluctuating swelling or abscess : **the pelvic peritonitis appears to be the sole active lesion ;** and the acute symptoms, particularly the pain, disappear speedily after colpotomy, even when no pus has been found.

Case 5.—A woman, 23 years of age, who had suffered for a long time with abdominal symptoms, was admitted to the Beaujon hospital in the following condition : during the previous day the pain had reappeared suddenly, extending over the whole of the abdomen, but with greatest severity in the right subumbilical region ; the abdomen was distended ; the face somewhat drawn. On the first day there had been some bilious vomiting, which had since recurred from time to time ; the pulse was strong, but rapid (120), the temperature was only 99·4° ; in short, we found all the signs of a fairly severe form of pelvic peritonitis. The diagnosis was confirmed by the results of a vaginal examination, which showed that the uterus was fixed and that Douglas' pouch was occupied by a soft and very tender mass.

The general condition remained the same during the following week, but the swelling behind the cervix became more and more prominent ; it bulged into the vagina, and became definitely fluctuant.

I performed posterior colpotomy, and opened the prominent swelling without any difficulty ; it contained eight or nine ounces of turbid serous fluid ; the cavity was intersected by several septa, and I could discover no other accumulation in relation with its walls ; it appeared to be bounded on either side by the adherent uterine appendages.

A drainage tube surrounded with gauze was placed in Douglas' pouch, and the vagina was packed. After this operation, which we considered simply a temporary palliative measure, the pains ceased at once, the peritoneal symptoms disappeared, and the result appeared so satisfactory to the patient that

[1] It is impossible to warn operators too strongly of the risks associated with these deep manipulations, and this is why we restrict the application of the vaginal operation to comparatively narrow limits. When a posterior colpotomy ceases to be a simple operation, it immediately becomes very dangerous.

she left hospital sixteen days later, deferring any more radical treatment to a later date if it should become necessary. She was able to resume her work.[1]

These cases show that there is **a form of pelvic peritonitis with copious serous effusion**, in which posterior colpotomy performed as an urgent operation, with simple evacuation of the fluid, can bring about the immediate disappearance of the pain, and the symptoms of peritoneal reaction, and thus be of very real benefit. I need scarcely say that this variety can only be admitted after careful examination and due verification ; in other words, one must always, after evacuation of the serous accumulation, no matter how copious it may be, make a careful digital examination of the wall of the cavity, and seek for the deep-seated pockets of which we have spoken above.

Whatever the nature of the lesions, **good drainage is the indispensable complement of the colpotomy**, particularly when, as is most frequently the case, pus has been found.

The drainage tube must be placed **right to the bottom of the cavity**, to the bottom of the second cavity in the cases where two pockets are superposed : provision must be made for keeping the tube in proper position, for which purpose a T-shaped tube is useful, and may, if necessary, be improvised out of two pieces of ordinary drainage tubing, but a simple tube will keep in place perfectly well if properly supported by the vaginal packing.

Apart from the cases in which a considerable oozing of blood renders some packing necessary, no gauze should be placed in the cavity : the drainage tube alone should be placed there, emerging through the incision, and should be cut short at about the middle of the length of the vagina ; strips of gauze must be placed around it in quantity sufficient to fill the vagina but not tightly packed.

When the temperature falls after the operation and does not rise again, when the fluid has not been of a very septic character—the contents of a non-suppurating hæmatocele, or the serous effusion associated with a mild pelvic peritonitis for instance—it will be well to leave the vaginal packing alone for several days : it will be taken out on the fourth, fifth, or sixth day, earlier, of course, if the temperature should furnish any indication for doing so, and the tube removed ; after free irrigation of the vagina and the retro-uterine cavity, it will often be sufficient to simply renew the

[1] Two other illustrations : A young woman, 25 years of age, after a menstrual period, was attacked with very severe pains in the iliac region, bilious vomiting, and abdominal distention ; the mobility of the uterus was diminished, and the posterior cul-de-sac was filled by a fluctuating swelling. Posterior colpotomy : I evacuated at least a pint of serous fluid, and penetrated into an incompletely closed cavity, in front and to the sides of which I could quite plainly feel the uterine appendages ; the left appendages were normal, while those on the right were prolapsed and adherent, the ovary being somewhat enlarged, but without any cyst, fluctuating mass, or pus. A strip of aseptic gauze was placed in the cavity and the vagina packed. There was a sudden cessation of the pain and the other symptoms. Eight months later the patient was reported to be quite well.

A woman, 27 years old, was taken suddenly ill with severe abdominal pains and greenish vomiting ; behind and to the right of the cervix a large tender rounded mass was felt, which appeared to extend to about two fingers' breadth above the pubes. Colpotomy and incision of the retro-uterine mass : a very large quantity, estimated at about a pint, of serous fluid escaped : drainage of the cavity ; rapid and lasting recovery.

vaginal packing without replacing the tube, and afterwards to change the gauze and repeat the irrigation daily or every second day. When the cavity has been very large, and particularly when it is very deeply situated, *the tube must not be removed too soon*, as it is the best guarantee of an uncomplicated, and sometimes lasting, recovery.

As a matter of fact, colpotomy, in the conditions which we have just been considering, ought to be considered as an emergency operation: it has given all the results that can fairly be expected when it has caused the subsidence of the acute and urgent symptoms which had rendered its performance necessary; and, in my opinion, it is as an urgent operation, and in meeting these indications, that its value is greatest and least open to objection.[1]

URGENT CLEANSING AND CURETTING OF THE UTERUS.

The indications for immediate uterine cleansing or curetting present themselves in two conditions:—

(1) In post-partum or post-abortum **uterine infection.**

(2) In cases of **uterine hæmorrhage,** due to partial or complete retention of the placenta or membranes after confinement or miscarriage.

We cannot here consider the question of curetting from the obstetrical standpoint.[2] The need for curetting arises very frequently, even apart from delivery at full time.

A practitioner is called to see a woman who has been ill for several days with alarming septic symptoms. She is pale, her features are pinched, the tongue is white and dry, the pulse quick (120, 125, or more) and small; the temperature ranges between 101° and 104°, and she has had several rigors; the abdomen is tender and a little distended; there is a fœtid, blackish, or dirty-grey vaginal discharge; the cervix is found to be enlarged, and the os patulous, while the fundus of the uterus extends some distance above the symphysis, and there is tenderness to pressure in the vaginal fornices.

On questioning the patient, the trouble is found to have begun with *a sudden and rather profuse loss of blood*, or at any rate that the other symptoms had followed the bleeding after a comparatively short interval, and further, that the bleeding had been preceded by a period of amenorrhœa of variable

[1] See in thesis of Jean d'Herbécourt, already quoted, the indications for colpotomy as a channel for exploration or drainage, or for the removal of pelvic organs, or as a step in certain plastic operations.

[2] A rise of temperature during the puerperium constitutes the principal indication. MM. Pinard and Wallich do not recommend curetting before the end of the third day after confinement; prior to that time they advise the use of intra-uterine douches or continuous irrigation. "If the temperature remains high and the pulse fast after a primary intra-uterine douche, curetting is advisable. Our experience has taught us that the operation ought to be practised if a second rise of temperature occurs after the administration of an intra-uterine douche or after the cessation of continuous irrigation." (Pinard et Wallich, *Traitement de l'Infection Puerpérale*, 1896.)

duration. The conclusions to be drawn are very simple: miscarriage, secondary septic endometritis, associated probably with retention of placental débris, and the urgent need for curetting for the purpose of cleansing and disinfecting the uterine cavity in the best manner possible.

Clinically, this is one of the conditions most often met with. How often, especially in daily hospital practice, do we get a repetition of the same story. The condition occurs particularly after miscarriages in the first months of pregnancy, sometimes overlooked, and almost always neglected by a certain class of the population.

In some cases the symptoms of **infection** appear at once after the abortion, or in the days immediately following, and these are usually the most serious cases. But infection may be delayed, and the symptoms, at first unobtrusive and usually neglected, do not attract serious attention until a variable number of days have elapsed. The same thing occurs after confinement, and I have repeatedly seen an ill-cared-for patient who, well or ill, had been allowed to get up, brought to hospital after fifteen, twenty, or thirty days, with fever, pain, signs of serious infection, bloody vaginal discharges, and a greatly enlarged uterus; repeatedly in such cases I have removed large masses of placenta, indeed even the entire placenta, in a condition of putrefaction.

Septic endometritis from retention of the products of conception presents itself with varying degrees of severity, from the mild initial form characterized simply by fever, uterine tenderness, and fœtid vaginal discharge, through a series of gradations which lead right up to fatal septicæmia. I need scarcely say that the single fact of a rise of temperature after confinement or miscarriage ought to arouse suspicion, and should be followed without delay by the first step in treatment, **an intra-uterine douche**; if that fails to bring down the temperature, curetting is necessary.

I may add that in the graver forms, where the infection expresses itself by threatening general symptoms, curetting will very often constitute only one portion of the treatment: repeated subcutaneous injections of salt solution in large doses form an indispensable complement to the operative measures. I could mention many cases where the free use of saline solution, administered in the ways we have already described, has appeared to me to be the chief factor in bringing about recovery.

We have here, therefore, a first series of very definite indications.

Hæmorrhage, due to the same causes, provides a second group.[1]

These uterine hæmorrhages occur generally at two different periods and with varying characteristics:—

A woman, after having missed—let us say—two periods, has a sudden flooding, and passes a great quantity of blood and clots. But the

[1] Here we can only deal with the complicated cases of placental retention; when the miscarriage has occurred in the presence of a medical practitioner, and the expulsion of the afterbirth is delayed, recourse may be had to various methods of treatment, no description of which will be given here. In our opinion immediate extraction of the retained placenta is always the best plan to adopt.

hæmorrhage does not stop after this apparent delivery; the bleeding persists, sometimes indeed the blood escapes in a continuous stream from the vulva, and soon produces symptoms of a dangerous degree of anæmia. Hot douches and gauze packing have no effect; as a matter of fact, under these circumstances such indirect measures are more dangerous than useful.

The following practical point must never be forgotten: if the uterus is bleeding, it is because it is not empty; it still contains some fragments of the ruptured ovum, and **it is only by emptying it that hæmostasis can be obtained**; the necessary object may sometimes be achieved by an intra-uterine injection; more often immediate removal of the retained tissues with the fingers, or by curetting, will be required.

In another case, after a miscarriage or a full-time delivery, the initial hæmorrhage is comparatively slight, but the woman continues to lose blood in varying quantities until she comes under observation, in a very anæmic condition, during a recurrence of the metrorrhagia one, two, three, sometimes even four months after the onset. Here, again, the necessary treatment is clearly indicated; curetting, performed as soon as possible, represents the only useful measure.

In these cases it is not uncommon to find placental fragments which have assumed an actual polypoid form (*Fig.* 8).

Fig. 8.—Intra-uterine placental polypus.

Operative Technique.—Either digital clearing or curetting will be performed; each method has its own indications.

Digital Clearing of the Uterus.—This is the method of choice, when it is necessary to remove adherent fragments of placenta from the uterine cavity during the days immediately following a miscarriage or confinement.

No special instruments are required, but if the procedure is to be simple, safe, and efficacious, it must always be considered as a real "operation"; and as such carried out with a definite method and with rigorous aseptic precautions.

General anæsthesia is always advisable, and should only be contra-indicated by the patient's general condition.

Whether anæsthetized or not, have the patient placed in the

gynæcological position, with the thighs supported by suitable apparatus, or by any available assistants, or secured to the bedstead by one of the methods previously illustrated. Shave the vulvo-perineal region and the upper parts of the thighs, and wash the whole area with soap and water; wash the vaginal walls carefully with soapy water; a suitable brush may be used gently for cleansing the vagina; give a large douche of warm boiled water, and then the actual operative manipulations may be begun. Here, as in so many other conditions, the preliminary precautions constitute an indispensable part of the operation.

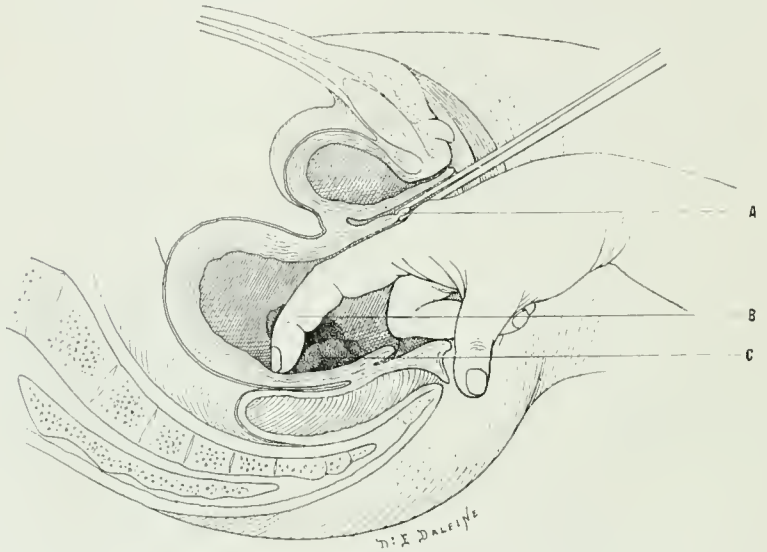


Fig. 9.—Clearing out the uterus with the finger. (A) Forceps holding the anterior lip of the cervix this forceps is only of use in some cases. (B) Index finger hooking out the mass of placental tissue. (C) Adherent placental tissue.

There are two stages in the operation:

(1) **To penetrate right to the fundus of the uterine cavity.**

(2) **To separate and extract the placental fragments.**

1. If the miscarriage or confinement has occurred recently, and the cervical canal is dilated, the first step offers no difficulty; and in any case when some part of the ovum is still retained within the uterus, the cervix always remains partly open and dilatable, and with some persistence the finger can be passed through it.

Apply the palm of the outspread left hand over the hypogastrium,[1] for the purpose of pushing down and steadying the body of the uterus; introduce the right index and middle fingers, and, if necessary, a part of the hand, into the vagina, push the tip of the index into the more or less

[1] Covered, of course, with a boiled compress.

gaping os; if one has to do with an abortion in the very early stages of pregnancy, or if the accident has occurred several days previously, another obstacle may be expected *above the internal os*, feeling like *a narrow, thick, firm ring*, which obstructs the entrance to the true uterine cavity. Sometimes the partition may seem to be complete, and might lead to the thought that the fundus had been actually reached if the hand on the hypogastrium did not indicate that such was not the case. Push the tip of the index finger against the centre of this dome-like partition; on no account must any undue force be employed; a slight screwing movement may be given to the finger, but the important point is to maintain **gentle, steady central pressure**; often it will only be after five, ten, or perhaps fifteen minutes, that the resistance will be overcome, but with patience the channel will always be successfully opened in the end, and bit by bit the "sphincter"[1] will soften and yield before the finger. Once the finger has reached the true uterine cavity, *go right to the fundus*, make sure of the position, and then determine the intra-uterine conditions by careful palpation. Most commonly the retained placental fragments will be discovered on the posterior wall or near to one of the cornua. Begin by separating the adherent mass from above downward by hooking the tip of the finger above its upper border, bring it down in the manner shown in *Fig.* 9, as it is freed from the uterine wall. Make sure that it is completely separated before attempting to remove it. If the cervix is wide, the fragments may be extracted without much trouble with the index finger, or it may be possible even to introduce two fingers into the uterus. If dealing with a very large mass or with the entire placenta, P. Budin's excellent method of **abdomino-vaginal expression** may be employed: the right index and middle fingers are pushed up as high as possible into the posterior vaginal fornix, and at the same time pressed against the posterior surface of the uterus, while counter-pressure is exerted by the hypogastric hand on the fundus and anterior surface of the organ: in this manner the mass may usually be expelled through the cervix. In some cases the best plan is to break up the mass and to extract it in fragments with the assistance of continuous irrigation, which washes away the débris and at the same time stimulates the uterus to contract.

Fig. 10.—Mass of placenta forming a pseudo-polypus.

2. If the separated mass is caught by the cervix and can be seen partly projecting into the vagina, its extraction may be completed by pulling on it gently with suitable forceps, but the use of forceps must be strictly limited to such conditions; **they should never be employed within the uterus.** Even in the conditions represented in *Fig.* 10, where placental tissue protrudes through the external os in the form of a blackish pseudo-polypus, it ought to be removed with the fingers, not with forceps; the invisible

[1] Pinard and Wallich, *loc. cit.*

intra-uterine portion of the mass is always unexpectedly large, and to remove it the finger must be passed into the uterine cavity above the upper border of the retained fragment, which can then be separated from above downwards and hooked down out of the cervix.

A copious intra-uterine injection of very warm boiled water is an essential part of the operation ; lastly, when the retained placental tissues are putrefying and friable, and break down under the slightest pressure, it will be well, after as much as possible has been cleared out with the finger, to complete the task by carefully curetting the uterine cavity.

Curetting.—Indications for this are fairly numerous, and it is the method of choice particularly when there are no large masses of placenta retained within or adhering to the walls of the uterus, but where the uterine cavity is still enlarged and open, and the mucous surface is contaminated by the presence of putrefying membranous débris and clots. Curetting is, in fact, the ordinary treatment required in cases of post-partum or post abortum uterine infection. And, further, it is a procedure which can be

Fig. 11.—Ordinary curette.

quite well carried out in almost any surroundings, and which requires no complex equipment.

A posterior vaginal speculum[1] (*Fig.* 2), a uterine vulsellum forceps, a curette, (*Figs.* 11, 12, 13) a uterine sound, and an irrigator, constitute all that is necessary for the performance of an urgent curetting.

These instruments, with the addition of a set of Hegar's dilators, a double-channel uterine tube,[2] and a pair of uterine dressing forceps, will constitute a very complete outfit.

The important point is to have a good **curette** and a good, easily sterilizable **irrigator,** provided with a glass nozzle of sufficiently small diameter to pass readily through the orifice of the uterus.

With regard to the curettes, there is ample choice between the numerous patterns. The principal ones are those of Récamier-Roux, Sims, and Simon, and custom is the chief factor in determining the choice : for my own part I prefer Sims' fenestrated instrument (*Fig.* 12) for curetting properly so-called, and a large ordinary curette (*Fig.* 11) for clearing the uterus of large masses of placenta ; and I think that a medium-sized Sims' curette and a large ordinary curette are all that are necessary for any urgent curetting.

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[1] It is often possible to dispense with the speculum, and to reach the cervix by depressing the posterior vaginal wall with two fingers.

[2] This instrument is not indispensable ; personally, we never use it. If the cervix is properly dilated, a simple glass cannula, properly handled, will fulfil all requirements.

Introduce the vaginal speculum, expose the cervix, seize its posterior lip with the vulsellum forceps, and draw the organ down gently to the vulva.

This is the painful step when a general anæsthetic is not employed; it may be rendered more troublesome and, indeed, sometimes almost impossible, by perimetritic lesions, recent or of old standing; but it is quite unnecessary to bring the cervix very low down, and any forcible traction is to be avoided.

Fig. 12.—Sims' curette.

Fig. 13.—Curette with flexible shaft.

The cervix is now exposed to view: in the cases under consideration it is often gaping, or at any rate sufficiently open to permit of the introduction of the medium-sized curette. It is not, however, at the external os that obstruction usually exists, but higher up, as we have already mentioned; further, it is advisable that the passage should be sufficiently wide, not only to give access to the curette, but also to allow of the free escape of the material removed with the instrument.

First introduce the uterine sound, which will give information as to the dimensions of the uterine cavity, its direction, and in some degree as to the nature of its contents; the instrument must be slipped in gently, without the exercise of any force, nor with any screwing movement; if any resistance is met with, *do not attempt to force the instrument*, but carry the handle upwards or downwards until the proper channel is discovered; there is hardly ever any real difficulty in the matter.[1]

If the cervical canal appears to be narrow, if the curette does not enter perfectly freely, progressive dilatation with Hegar's bougies may be employed. Generally speaking, it will be sufficient if three or four sizes are passed, no undue force must be used, but it is necessary to introduce the bougies for a distance of 2 inches at least in order to make sure that the internal os is properly dilated. The required preliminary dilatation may also be obtained by introducing the closed blades of a uterine dressing-forceps through the internal os and then withdrawing the instrument with the blades open, progressively increasing the angle between the blades with each repetition of the act; but the dilatation thus produced is less uniform, and if forced to have recourse to this method the possibility of causing fissures in the cervical wall must always be kept in mind, and at each repetition the points of application of the blades around the circumference of the canal must be varied. The curette is then introduced, and the further steps vary according to the nature of the contents of the uterus. Push the curette in until it comes into gentle contact with the fundus of the uterus, the distance of which from the external os has already been determined by

[1] Of course, when dealing with a case in which miscarriage or delivery has recently occurred, and in which the cervix is widely open and the uterine cavity dilated, the uterine sound is quite unnecessary, and if badly handled may be a dangerous instrument: in such cases it is with the finger the interior of the uterus ought to be explored: and, indeed, in any case where it is possible, digital examination of the uterine cavity is always the best method of investigation.

the uterine sound; draw the instrument down the whole length of the posterior wall, pressing gently and without trying to elicit that famous "uterine cry" which ought not to be heard in these cases. A soft and friable uterus does not "cry" under the curette; it is not the ear but the hand which must be the guide, it is the hand which will convey the peculiar sensation of scraping against denser, more resistant tissue, and will enable the operator to recognize that the desired result has been obtained. The tracks of the curette should be made longitudinally from above downwards and close together over the whole of the posterior surface, then the curetting will be repeated in the same way on the anterior wall and on the right and left borders. The fundus and the cornua are the parts least easy to curette satisfactorily; however, the difficulty can be overcome by drawing the instrument from one side to the other, or from before backwards; it is also at these points that perforation of the uterus is most to be feared, particularly on the posterior wall close to one or other cornu.[1]

It has twice happened to me, in the course of curettings preliminary to hysterectomy, to thus perforate the uterine wall (without any bad result however), and in each case the perforation was situated at the point above indicated. Although a perforation may not be very serious when hysterectomy follows immediately, it would be a very different matter in a curetting performed for septic puerperal endometritis, and the accident has repeatedly been attended with disastrous results, particularly when the perforation has not been at once recognized.[2]

It is advisable, during the curetting, occasionally to draw the instrument outside of the cervix in order to dislodge the clots and the scrapings of mucosa; anything that remains will be washed away by an intra-uterine douche administered in the way we shall immediately detail.

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[1] This accident may undoubtedly occur at any point in the uterus, but is chiefly to be feared in the neighbourhood of the fundus; and the fact is to be explained by the movement of the curette in that region, and not by any supposed maximum friability; perforation also occurs at the isthmus, particularly in cases where the organ is markedly flexed, and exceptionally at the borders between the attachments of the layers of the broad ligaments.

[2] It will be well to recall some cases of this kind. A medical man was called to see a woman after an abortion. After several unsuccessful attempts to empty the uterus with the finger, he introduced forceps into the cavity, and thinking that he had got hold of a piece of membrane, drew *a loop of intestine* out through the vulva. Veit, who was summoned at once, reduced the intestine without difficulty, and performed vaginal hysterectomy scarcely an hour after the accident. Two days later the woman was dead of septic peritonitis. (Reported by Martin, *Presse Médicale*, 9 juin, 1894, p. 84.)

Another case. A woman, 38 years of age, confined a month before. Since then, continual hæmorrhage. She was curetted at home under chloroform. At the end of the curetting the doctor could pass his curette right up to the handle, and concluded that the uterine cavity was very greatly enlarged. The uterus was irrigated with a solution of sublimate (1–1000): the fluid was not returned, but no notice was taken of this fact. At 9.40, when the patient recovered consciousness, she was very pale, and complained of severe abdominal pains; at noon the pains were worse and the pulse was very bad. At 8 o'clock she was unconscious. At 3 o'clock she was dead, six and a half hours after the *intraperitoneal injection of sublimate*. (Quoted by Javle, *Thèse de doct.*, 1895.)

As a rule, the occurrence is indicated by the abrupt cessation of resistance and by the curette passing deeply: the curetting must at once be discontinued, the clearing out of the uterus completed as quickly as possible, and the cavity packed. On no account must any douche be given. If the condition is one of infectious endometritis, or, if the perforation is not recognized until after an intra-uterine douche has been given, then immediate laparotomy is necessary, followed by suture of the perforation, or, if the lesions are very extensive, by hysterectomy. (See P. Rébreyend, *Les plaies perforantes de l'utérus*, Thèse. de doct., Paris, 1901; and Morlet, *Perforation de l'utérus puerpéral post-partum et post-abortum*, Thèse de doct., Paris, 1905.)

Whether the finger or the curette has been used, **the important point is to empty the uterus completely**; to leave nothing behind; *gauze swabbing and irrigation of the uterine cavity* constitute the final steps in completing this programme.

Lay aside the curette and roll a strip of sterilized gauze around the uterine sound or the blades of the uterine forceps, introduce the instrument into the cavity, and rub the walls longitudinally; take care that the tip of the instrument is well covered with a thick layer of gauze with which to rub the fundus. This rubbing, carried out methodically and gently, finishes the mechanical cleansing; in our opinion the very simple arrangement above described is much better than any form of intra-uterine brush. The latter, of course, is used in an exactly similar manner.

If desired, the gauze may be saturated with creosoted glycerin or tincture of iodine, but we have little faith in the efficacy of an agent which is only in contact for a few seconds with the surface to be treated, nor do we think that the value of intra-uterine injections of any of the various antiseptic solutions has been demonstrated; on the other hand, the use of strong and caustic solutions is associated with considerable danger.

It is much better simply to wipe out the cavity carefully with gauze, and then to irrigate it freely. Simple boiled water or, better still, boiled salt solution, in large quantities, is the most suitable medium to employ for the irrigation. Introduce the double-channel tube or glass nozzle, whichever one has at disposal, well into the uterine cavity, and allow three or four pints of fluid to run through; very little pressure should be employed, especially at first, and the intra-uterine tube should be withdrawn from time to time to allow the uterus to empty itself and to ascertain that the fluid is escaping properly; lastly, the vagina, in its turn, will be cleansed by swabbing and irrigation.

Never pack the uterus, nor, under the pretext of providing drainage, place a thick mesh of gauze in the cervical canal and uterine cavity; such a mesh would very soon become saturated with the discharges and act as a tampon: packing the uterus is an irrational plan which, even when there is hæmorrhage, will defeat its own object by preventing the organ from contracting properly.

Here, again, if the cavity has been completely emptied, it is the action of the muscular wall of the uterus which stops the bleeding. Be content with placing a narrow strip of aseptic gauze in the cervical canal, and fill the vagina with crumpled strips of gauze, but being careful not to pack it tightly.

In some cases the uterus continues to bleed profusely even after it has been emptied, and the bleeding is only partly checked by very hot intra-uterine injections (113° F. to 115° F.); firm packing of the vagina is then indicated, and the plug must be left in place for a sufficient length of time (twenty-four or forty-eight hours). ?

A narrow strip of gauze is introduced as before, through the cervix right to the bottom of the uterine cavity; then, long strips comprising several thicknesses are packed successively into the posterior fornix, into

the anterior fornix, below the cervix, and layer by layer down to the vulva; a surprisingly large quantity is always required to properly fill the vaginal cavity; firm packing is necessary if the gauze plug is to be efficacious; it is harmless if carried out methodically and gently, with the posterior vaginal wall well depressed with a retractor or with the fingers, and with the lips of the vulva held widely apart.

After these operations, whether the uterus has been packed or not, it is the temperature which provides the indications for the after-treatment. Should there be no fever, the vaginal dressing is best left alone for several days (five to seven); if the temperature rises again, or if it remains continuously up, intra-uterine injections ought to be employed without delay, and sometimes symptoms pointing to the necessity for a second curetting may present themselves. The latter possibility is, however, very exceptional if the first operation has been properly and aseptically performed.

HÆMATOCOLPOS.

A young woman, 17 years of age, was sent to us at the Tenon Hospital, suffering from very acute abdominal pain which had begun suddenly, two days before, in the hypogastric and iliac regions, associated with nausea and abdominal distention: it was thought that she was suffering from appendicitis.

The examination, however, showed the following condition: on abdominal palpation, a large rounded tumour was discovered extending four inches above the pubis and surmounted by a much narrower, hard, and cylindrical prolongation. The tumour was very tense, but gave a feeling of deep fluctuation, and could be taken between the hands and moved a little laterally. No vaginal orifice could be found: the labia majora were separated by a very tense rounded swelling of a blackish colour, which was quite evidently in continuity with the abdominal swelling, and was bounded below by a membrane occluding the vagina completely in the hymeneal area.

The case was, therefore, one of retained menstrual secretions behind an imperforate hymen, that is, a hæmatocolpos. The patient, who had been married for six months, had never menstruated; some transitory colicky pains, each month, the significance of which had been quite unknown to her, were the only troubles of which she had complained; however, for some months, and more particularly since her marriage, these monthly pains had become more severe and more lasting, but had never attained to their present severity.

Forthwith, after careful preparation of the vulvo-perineal region, I made a short median incision, about half an inch in length, at the centre of the bulging area; a very large quantity of thick black blood escaped: finally, I enlarged the incision a little, to allow of complete evacuation; the abdominal tumour disappeared, and the uterus, normal in size, could be felt behind the symphysis. A warm douche was given, a short strip of gauze

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was placed in the vaginal orifice, and a sterile dressing applied over the vulva. The pain disappeared at once, and the patient left the hospital cured, at the end of ten days.

In 1 had occasion to practise a similar operation in December, 1906, on a girl, 18 years of age, who had an enormous abdominal swelling extending up to the umbilicus and more prominent on the right side (*Fig.* 14); as in the preceding case, the vagina was occluded by an imperforate hymen, which was distended by a prominent swelling. There was only very slight tenderness on abdominal palpation; the patient had never experienced anything more than moderately severe colicky pains, and some passing feelings of uneasiness each month: the abdominal swelling had increased in size very slowly. As before, I made a very short incision at the centre of the distended membrane: a jet of dark blood escaped from the opening, and I refrained from hastening the expulsion by any pressure on the hypogastrium; when the enormous abdominal swelling had in this way been allowed to diminish very slowly, I enlarged the incision a little, and allowed what remained of the accumulation to escape; the vagina was irrigated with warm sterile water, and a small strip of gauze placed in the incision. Recovery took place without any complication.

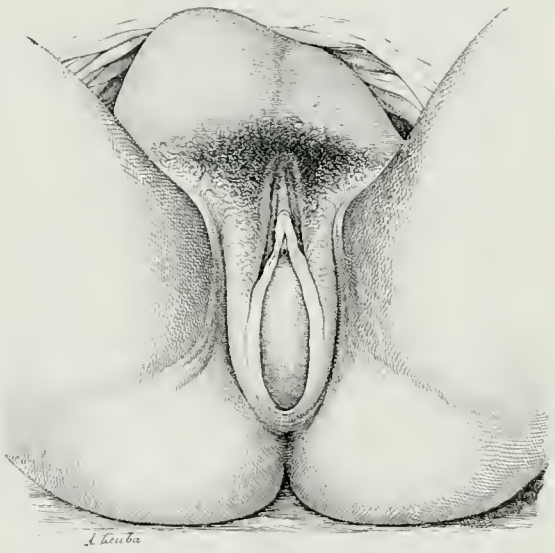

Fig. 14.—Hæmatocolpos.

Uncommon though they are, these cases of retention of menstrual secretions due to imperforation of the vagina must still be kept in mind; one must be aware of the dangers associated with them, and know in what cases it is advisable to intervene without delay, and be acquainted with the technical details to be observed in dealing with them.

The two cases which I have related were due to imperforation of the hymen: that is the most common form, and the distention then usually affects the vagina alone; behind the hæmatocolpos, the uterine cervix is perhaps more or less dilated, but the body of the uterus remains unaffected. Sometimes, however, the uterine cavity is also distended (*hæmatometra*); and again, the retained secretions may also occupy the tubes, giving rise to a *hæmatosalpinx*, sometimes of considerable size.

In the presence of a hæmatocolpos resulting from a low-seated, vaginal imperforation, one must always remember the possible existence of these other more deeply-situated accumulations, and seek for the uterus at the upper pole of the suprapubic swelling; if the uterus is not distended, it can be recognized more or less definitely as a narrow, hard prolongation in the middle line, or perhaps deviated to one side or the other. In such a case, where the uterus is found to be normal, the chances are that the tubes are also unaffected; but this is not certain, as hæmatosalpinx is not due exclusively to reflux of the secretions, but also to local hæmorrhages from the tubal mucosa.

The existence of hæmatosalpinx always renders the prognosis more serious; as a matter of fact, it is almost always the tubes that are affected by the ruptures, spontaneous or post-operative, which sometimes occur in these cases.

Intraperitoneal rupture of one or other segment of the distended genital tract is one of the chief dangers associated with retention of menstrual secretions; therefore, in cases with very large, very tense, and rapidly increasing swellings, immediate operation is the prudent course; pain and abdominal reactions are further indications. Another danger associated with hæmatocolpos is infection which may follow incision of the occluding membrane; it is particularly to be feared in cases where there are very large accumulations, especially when associated with hæmatometra and hæmatosalpinx, and must be guarded against with the greatest care when operation is performed.

It would therefore be wrong to describe the necessary operation too briefly by simply saying: incise the imperforate hymen and empty the cavity: although the actual operative steps may be reduced to these two simple terms, the whole procedure demands special precautions and a definite technique.

First, it must be carried out with rigorous asepsis; the vulva will be shaved, washed with soap and water, swabbed with alcohol and warm sterile water, as if a vaginal hysterectomy was to be performed. Never puncture the membrane with a trocar; make an incision with a scalpel, and remember that the thickness of the membrane varies considerably; the initial incision ought to be very short—about half an inch—to prevent a too abrupt escape of the contents. Let the cavity empty itself very slowly; not until it has decreased by about two-thirds should the incision be enlarged; remember that it is never certain that there are not two distended tubes attached to the chief swelling, and that if the evacuation is too rapid, and the consequent subsidence of the uterus too sudden, the tubes may be dragged upon and may rupture.[1]

---

[1] In 65 cases of gynatresia with hæmatosalpinx, collected by M. Fuld, there were 48 deaths, of which 39 occurred after operation. (Fuld, "Die Salpingotomie wegen Hämatosalpinx bei Gynatresie." *Archiv. f. Gynæk.*, 1889, t. xxxiv., No. 2, p. 131). If the incision of a hæmatocolpos should be followed by symptoms pointing to the occurrence of a rupture (analogous to the symptoms of tubal rupture in a case of ectopic gestation) laparotomy ought to be performed at once.

Therefore, do not hurry over the first step. Irrigation with warm sterilized water to ensure the complete evacuation of the retained secretions is good practice ; use no gauze packing, but leave a small strip of aseptic gauze in the vaginal orifice, and protect the vulva carefully with an aseptic dressing.

WOUNDS OF THE VULVA AND VAGINA.

We must distinguish between *wounds caused by falls astride*, on blunt or sharp-edged objects or on pointed bodies (vaginal impalement), and *wounds produced during coitus*.

Some years ago I was called in haste to see a young girl who had sustained a bad cut of the right labium majus through the chamber utensil breaking under her : the bleeding had been considerable, but it was checked by packing the wound with gauze soaked in gelatin solution. *Falls astride* on the edge of a plank or a pail, on the framework of a bed or the back of a chair, etc., are the most common causes of vulvar wounds ; these are of variable extent, and occupy the inner surface of the greater and lesser labia : they bleed terribly, the hæmorrhage being due to rupture of the bulb of the vestibule, which is crushed and cut between the wounding object and the ischiopubic ramus.[1] These injuries may be attended with fatal results when they occur during the course of pregnancy, or when vulvar varices are present.

In dealing with these injuries neither pressure-forceps nor ligatures are of much use : the best plan is, after having carefully cleansed the whole region (and the vagina) with very warm boiled water, to pack the wound tightly, and to secure the packing in position by a T-bandage or a double spica firmly applied over a thick dressing, and to fasten the thighs together. Some deep hæmostatic sutures may also be useful.

The bleeding is still more serious in cases of vaginal impalement from falls on stakes, pitchforks, etc., or when the patient has been gored by a horned animal, and these injuries are often associated with deeper and very serious lesions : lacerations of the vagina, or of the posterior fornix, perforation of the bladder, the rectum, or the peritoneum, or traumatic vaginal hernia. A very careful examination is therefore absolutely indispensable ; if any visceral perforation is discovered, it must be dealt with in the manner we shall describe later when dealing with rectal injuries ; hæmorrhage is best controlled by hæmostatic suture, combined with gauze packing.

Vulvovaginal lacerations occurring during coitus are not very uncommon : they are usually situated in the posterior fornix, or on the posterior wall of the vagina, but the position is very variable. Some twenty years ago I

[1] Tuffier et Lévi. "Chutes à califourchon chez la femme : hématomes et déchirures vulvaires." (*Semaine Médicale*, 1895, p. 277.)

saw a young woman die as a result of a comparatively small rupture of the hymen and lesser labium, sustained during the first sexual congress. In hæmophilic individuals, these vulvar wounds, multiple fissures of the hymen, lacerations of the lesser labia, etc., suffice to cause serious and dangerous hæmorrhage. Sometimes a fissure, often transverse, and of varying depth, is found on the posterior vaginal wall, or in the posterior fornix opening into Douglas' pouch: the rectum may be perforated,[1] and diffuse peritonitis has been observed. When dealing with an accident of this kind, a very complete examination is therefore necessary; if a bleeding fissure of the vulva or vagina is found, do not spend too much time in trying to seize the bleeding points with forceps, but suture the wound, passing the needle deeply and taking a good hold of the tissues: that is usually the best means of obtaining hæmostasis.

PERINEORRHAPHY.

A perineal laceration may also result from external injury, but most commonly it occurs during parturition. We cannot discuss the mechanism of the accident as it occurs at childbirth, nor the means of preventing it, but must content ourselves by saying that rupture of the perineum is so common, and its possible consequences are so serious, that immediate repair of the lesion is a work of necessity. This is an operation which every practitioner ought to be able to do, and to do well. Even apart from the complete ruptures, the cloacæ, the disabilities many women in certain classes suffer for years, how many cases of uterine infection and prolapse, and pelvic disease, would be avoided if immediate suture of the torn perineum was always performed? I say immediate suture; as a rule, the perineal repair ought always to be undertaken as soon as the delivery is complete; even if the patient's

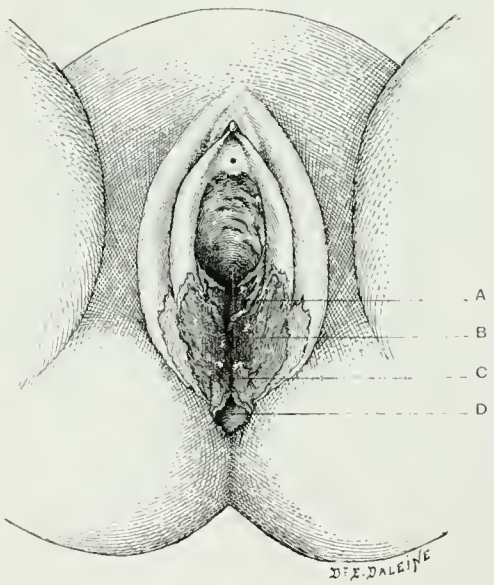

Fig. 15.—Complete rupture of the perineum. (A) Laceration in the vaginal wall. (B) The bleeding lateral wall of the rupture. (C) Rectum. (D) Anus gaping, torn through the anterior commissure.

[1] And a recto-vaginal fistula may result. (Nano, *Soc. de Chir. de Bucharest*, 23 oct., 1902.)

condition should appear to demand some delay, it should be as short as possible, not more than a few hours: by following this plan, the channel is closed against infection, fresh, healthy tissues are brought together; and, further, the suturing can be done so quickly as to add very little to the demands on the patient's strength. *The operation ought to be done at once:* that rule remains the best, from all points of view.

In different cases lesions of varying extent and depth will be found: here are the three chief possibilities, in order of gravity and also of diminishing frequency: (1) *Incomplete rupture*, limited to the fourchette, or extending some way into the perineum, but without involving the anal sphincter; (2) *Complete rupture*, from the fourchette to the anus inclusive, laying the whole perineum open from the vagina to the rectum, and even extending into the recto-vaginal septum; (3) *Central rupture*, through the perineum, leaving a band of tissue intact in front of the anus, and another at the fourchette, and opening internally on the posterior wall of the vagina.

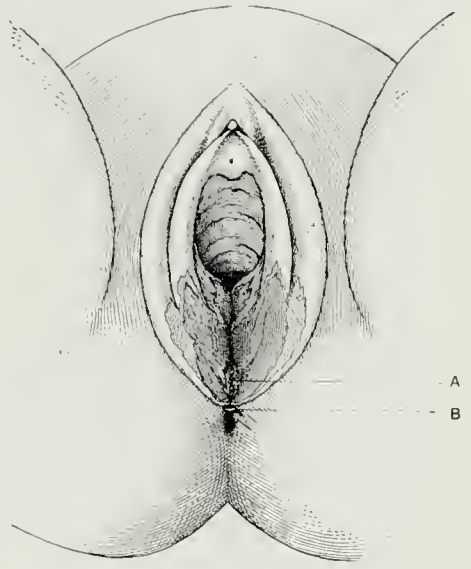

Fig. 16.—Complete rupture of the perineum; perineorrhaphy. 1st step: repair of the rectal wall. (A) Continuous suture uniting the extramucous portion of the rectal wall. (B) Suture restoring the anterior commissure of the anus.

1.— **Incomplete Rupture.**—A few words only will suffice. Do not use serrefines, but close the wound in a proper surgical fashion, that is to say, by bringing together not merely the edges of skin and mucous membrane, but the whole thickness of the divided tissues.

Therefore, if the tear involves the perineum and extends to some depth, first of all, with a Reverdin or any large curved needle, introduce two or three deep, transverse sutures, entering and emerging at about a quarter of an inch beyond the edges on either side, and passing below the bottom of the wound; tie them gently, sufficiently to bring the two surfaces in broad contact, but not so tightly as to tear through the bruised and friable tissues. Then the skin edges should be accurately adjusted by a few superficial sutures.

What suture material should be used: catgut, silk, silkworm gut, or silver wire? If good catgut is available, fine and strong, there is nothing better, and once the sutures have been introduced they need not be touched again: personally, I have long given the preference to catgut, and use it for almost all my perineorrhaphies. If desired, silkworm

gut may be used for the deep sutures, including the whole thickness of the tissues on either side, and catgut for the superficial adjustment.

2. Complete Rupture.— In these cases it is necessary to suture successively: (*a*) *The rectal wall*; (*b*) *The vaginal wall*; (*c*) *The intermediate angular space.*

General anæsthesia is almost always indispensable. Have the patient placed in the gynæcological position, wash and thoroughly prepare the whole region, then take careful note of the condition (*Fig.* 15): in front, is the torn fourchette and vaginal wall; behind, the two portions of the anal sphincter and the fissured rectal wall. Abstain from any excision of tissues with the object of obtaining regular surfaces: the bleeding tissues do not need any freshening; their contused appearance and doubtful vitality is often apparent only; be content with clipping off any torn blackish tags of tissue, but make no attempt to obtain straight and regular edges.

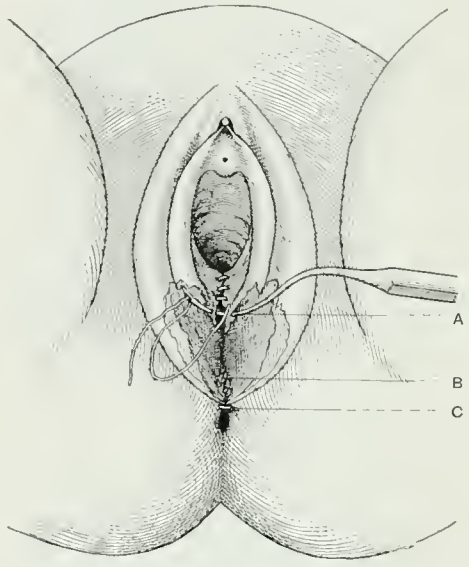

Fig. 17.—Complete rupture of the perineum: Perineorrhaphy. 2nd step: repair of the vaginal wall: (A) Needle picking up the whole thickness of the vaginal wall. (B) Continuous suture in the rectal wall. (C) Suture at the anterior commissure of the anus.

First, suture the V-shaped gap in the rectal wall. If the tear is extensive, bring the two sides of the inverted V together by gripping them at the anal margin with a pair of Kocher forceps: make the two edges equally tense, then *begin the suture above the upper angle of the gap*, and work from above downwards. Use a continuous suture of catgut or fine silk, place the stitches close together, and *include only the extra-mucous tissues:* when the anal margin is reached, pass the last turn of the suture so as to approximate the anterior anal commissure accurately (*Fig.* 16). Now direct attention to the laceration in the vagina. Here, again, use a continuous suture, commencing at the upper angle, but including the whole thickness of the wall as depicted in *Fig.* 17, taking care that the last stitch restores the fourchette.

The anus and the vulva have now been restored to their normal forms: the central portion of the laceration, **the perineal angle,** still remains to be dealt with; its repair is the capital step in the operation, it is the keystone of the arch.

Here, again, in order to get a satisfactory result, the two opposed surfaces of the gap must be brought in contact over their entire depth,

right to the bottom of the gap, without leaving the slightest dead space. That is the whole secret of a good perineorrhaphy.

If the space is not too deep, it may be possible, by using a large needle with a good curve, to close it with three or four sutures, each suture passing beyond the summit of the space, and including the whole of the bounding tissues in its grasp.

More often, however, it will be better to bring the perineal tissues together by means of one or more buried continuous catgut sutures: in this way the gap will be progressively closed from within, and reduced to a superficial anteroposterior fissure (*Fig.* 18). It will then only remain to adjust the skin edges by some interrupted sutures (*Fig.* 19); the most posterior suture should be passed deeply, close to the anus, for the purpose of supporting the anterior commissure.

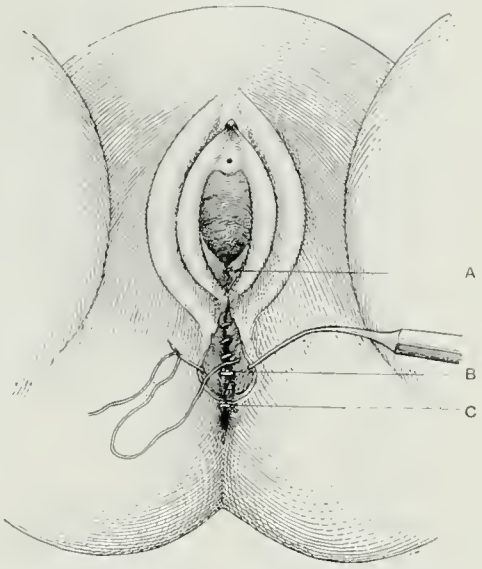

Fig. 18.—Complete rupture of the perineum. 3rd step: suturing the perineal portion of the tear. (A) Continuous suture uniting the vaginal portion. (B) Continuous suture uniting the perineal tissues; needle passing across right at the bottom of the space. (C) Suture at the anterior commissure of the anus.

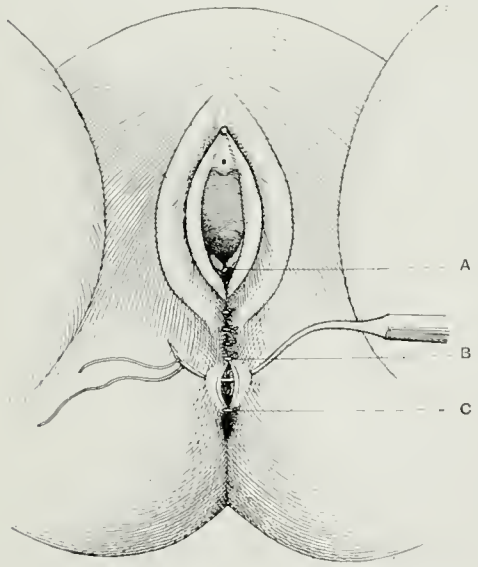

Fig. 19.—Complete rupture of the perineum: perineorrhaphy. 4th step: suturing the skin of the perineum. (A) Suture at the fourchetta. (B) Interrupted sutures in the skin of the perineum. (C) Suture at the anterior commissure of the anus.

3. Central Rupture.—Here the necessary treatment is somewhat more complicated. There are two openings, *one in the posterior vaginal wall, the other in the centre of the perineum.* If these openings are simply closed separately, a dead space will be left, with bruised and lacerated walls, between them at the centre of the perineal body, and the ultimate results will be very doubtful.

The best plan is deliberately to extend the rupture in the direction of the vagina,

by dividing the bridge of tissue intervening between the vaginal and perineal openings. The condition will then be that of a very large "incomplete rupture," and after having cleansed and trimmed (under the reservations already mentioned) the widely separated surfaces, the next step will be to suture the vaginal wall from above downwards, and then to restore the perineal body by one or more continuous sutures, finishing by carefully suturing the skin edges.

VULVO-VAGINAL ABSCESSES.

A few words only are necessary with regard to the abscesses occurring in the vulvo-vaginal region : *acute suppurative inflammation of Bartholin's gland—abscess of the labium majus—suburethral abscess.*

Acute suppuration originating in Bartholin's gland is very often seen ; extensive unilateral œdema of the vulva should always cause one to think of an abscess of the vulvo-vaginal gland—or of a chancre. In a case of acute bartholinitis the labium majus is red and swollen, particularly in its posterior third ; but the overlying skin remains mobile and more or less supple, while the prominence shows itself on the inner surface of the labium, obstructing the vaginal orifice and opening up the layers of the lesser labium.

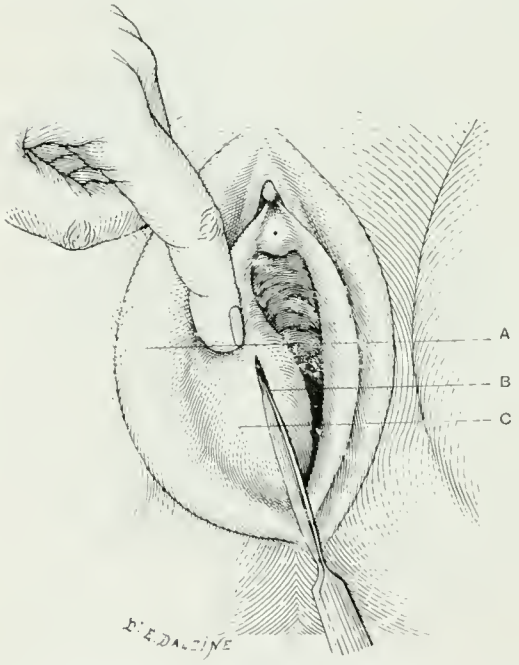

Fig. 20.—Abscess of the vulvo-vaginal gland. Incision on the vaginal surface of the swelling. (A) Labium majus. (B) Commencement of the longitudinal incision. (C) Prominence of the abscess, on the inner surface of the labium.

It is on the inner side that the swelling should be incised (*Fig.* 20). Incise early, in a direction parallel to the long axis of the labium and over an extent sufficient to ensure immediate complete evacuation and subsequent good drainage. We know that fistulæ not uncommonly follow these suppurations ; a small puncture is very likely to produce such an undesirable result.

Such badly-opened abscesses and fistulæ can only be cured by excision, a somewhat troublesome operation which, to be efficacious, must be complete : scraping is insufficient : the cavity must be incised from end to end, and the two portions of the wall dissected out from the surrounding labial

tissues, the dissection going beyond the inflammatory focus, and beyond any diverticula which may be present. There is a good deal of bleeding, which is best controlled by deep hæmostatic sutures.

An abscess of the labium majus is more uncommon, and presents different appearances: it occupies the whole length of the labium, which is all red, tense, œdematous, and fluctuating; the swelling is quite as prominent, if not more so, on the outer as on the vaginal surface, and the lesser labium is not affected. If the extremities of the swollen labium are taken between the thumb and fingers, the mass feels like a flattened arch, and fluctuation can be transmitted from one pole to the other. Left to themselves these abscesses often open to the outer side on the skin surface, or perhaps in the nympho-labial groove. They ought to be incised at the most prominent point, and usually a free incision on the external surface of the labium in the middle of the swelling provides the best drainage.

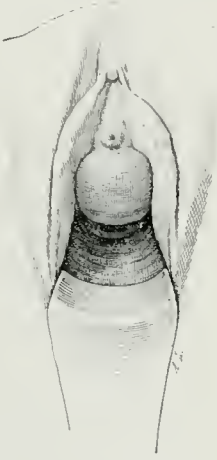

Fig. 21.—Sub-urethral abscess.

Lastly, there are the sub-urethral abscesses, the abscesses in the urethro-vaginal septum.[1]

They develop at the posterior surface of the urethra, and appear at the entrance of the vagina, a little behind the meatus, as red, irregularly-rounded swellings (*Fig.* 21), which at first sight resemble a urethro-cystocele; but the swelling is very painful, and fluctuates; the mucosa over it is œdematous, and, on introducing the finger into the vagina, it is observed that the swelling does not extend into the vesico-vaginal septum, but forms a boss below the urethra, and usually, if it is compressed, some drops of pus escape from the meatus. These abscesses ought to be incised longitudinally, in the median line, and as soon as possible, to prevent them from opening into the urethra.[2]

NEPHROTOMY AND RENAL DECAPSULATION.

Calculous Anuria.—The practitioner is summoned to see a patient who for two, three, or perhaps four days *has passed no urine*; he suffers from renal lithiasis, and has had many most characteristic attacks of renal colic; the anuria had appeared during the last, quite recent, crisis, the pains of which have not yet disappeared. Suddenly, or after some days

[1] I am here speaking only of the large acute sub-urethral abscesses; they are less uncommon than is generally believed; I have seen three very definite cases during the last few years. In addition to this variety, there are also the small abscesses or the laterally situated suppurating tracks which usually occupy Skene's ducts. (See our article, "Les abcès sous-uréthraux chez la femme. *Semaine Médicale*, 29 juillet, 1908.)

[2] That is not a favourable termination, because the abscess drains badly, urine penetrates into the cavity, and the affection has a great tendency to become chronic.

of diminished secretion, micturition had ceased. Of course the first care must be **to determine if the bladder is really empty**; nothing can be felt on palpation of the hypogastric area; a catheter is passed, but no urine escapes. It is therefore clear that the condition is one of renal retention.

The history indicative of pre-existing calculous disease, and the scarcely terminated attack of renal colic, exclude any possibility of doubt as to the nature and causation of the anuria; further, the localization of the pains during the last attack indicates the side on which the obstruction is situated and on which the necessary operation must be performed. The primary indications are confirmed, and often completed, by the physical examination of the kidney and ureter; on bimanual examination (*Fig. 22*) the kidney

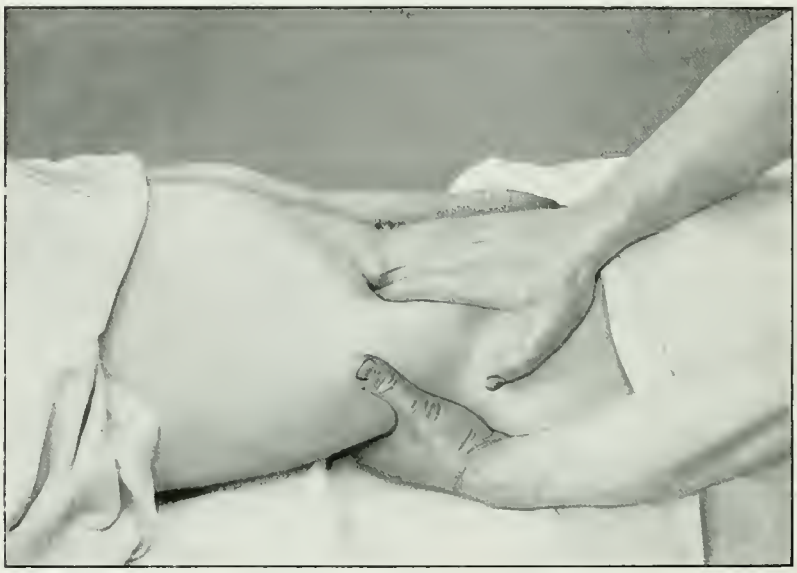

Fig. 22.—Bimanual examination of the kidney.

on the painful side is found to be enlarged and tender, there is also tenderness along the ureter, elicited by pressure over a line extending vertically upward from the middle of Poupart's ligament, or perhaps by pressure applied by way of the rectum on the base of the bladder above the prostate. As we shall see presently, these results, obtained by direct examination, constitute indispensable diagnostic factors in some less definite cases.

Obstruction of the neck of the renal pelvis or of the ureter by an impacted calculus is the natural conclusion, and one which is almost always correct. Before going further, let us, however, consider a difficulty which naturally presents itself.

This calculous obstruction is unilateral: at any rate it is quite exceptional and very improbable that the accident should occur simultaneously on

both sides ; what, then, has become of the second kidney, and how is the complete absence of excretion to be explained when apparently one urinary channel only is obstructed ?

The second kidney is sometimes absent altogether ; or if present it may be atrophied, sclerosed, and functionless ; or again, if though diseased it still possesses some functional value, its activity may have been inhibited reflexly by the lesions of the opposite kidney or ureter. As a practical conclusion, it is impossible to depend on the " second kidney " to overcome the anuria, and no time should be lost in attempts, which almost inevitably fail, to stimulate it to action.

The situation is difficult in another way when the anuria appears primarily without preceding pains, and without the train of symptoms associated with an attack of renal colic. The question then is, Is it a case

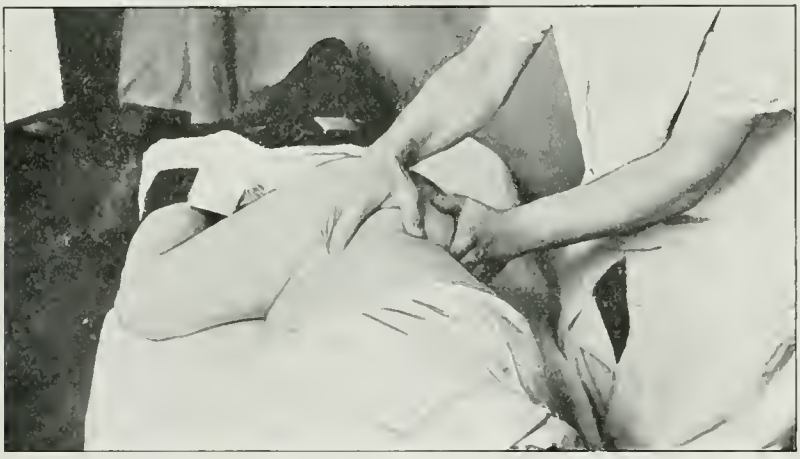

Fig. 23.—Examination of the kidney in the lateral position with the thighs flexed.

of anuria from obstruction, that is, from renal retention, or *one of true anuria due to defective secretion ?*

When calculous obstruction is the cause, it is very seldom that some indications of pre-existing lithiasis, mild renal crises, passage of gravel, bloody urine, etc., are not found in the patient's history ; it is also uncommon for the patient neither to have felt some lumbar pains nor to have passed a little blood in the days immediately preceding the development of anuria. Very often indeed in these cases, on exploratory catheterization some blood will be found in the bladder. Finally, even when the kidney cannot be felt, even in the lateral position (*Fig.* 23), the pain produced by deep pressure in front, laterally, or behind in the costo-vertebral angle, the painful contracture, and the defensive reaction of the muscular wall, are sufficient indications of the side affected.

This " defensive reaction of the wall," which we have already repeatedly

mentioned when speaking of appendicitis, ruptures of the intestines, etc., is here again a clinical sign of the first importance, and is sometimes the principal or even the sole diagnostic factor.

For instance, take a case operated on by Legueu: The man had been taken ill five days before with a sudden pain in the left flank, and vomiting; anuria occurred at once and uræmic symptoms soon followed. "On the left side, and on that side alone, palpation of the flank aroused a reflex contracture, a sort of defensive reaction of the abdominal wall, and it was on that single fact, added Legueu, that I based the diagnosis of recent calculous obstruction of the left ureter." [1]

There is, therefore, somewhere in the length of the ureter or in the renal pelvis, a mechanical obstruction, an impassable barrier damming back the urine under such high pressure as to suspend renal secretion. What is to be done? **Incise the kidney, and open and drain the pelvis through the renal tissue.** This constitutes nephrotomy.

When should the operation be performed? The general condition of the patient will furnish the reply.

Uræmia is the danger, the more serious because at the outset it is not indicated by any conspicuous symptoms, because the intoxication progresses slowly until it suddenly reveals itself in an irremediable form. Watch, therefore, for the signs of commencing uræmia: drowsiness, sometimes interrupted by excitement or low delirium, vomiting, dryness of the tongue, contraction of the pupils, muscular tremors; if these are present, do not wait for any further indications, but operate at once.

I am well aware that the period of tolerance is sometimes prolonged, and that anuria has been known to last for five, ten, or twelve days; I know also that spontaneous expulsion of the obstructing calculus, followed by profuse discharge of urine, has been observed on the fifth day.[2]

But on the other hand, uræmic convulsions may suddenly break out on the third day, and the wise practical rule is as follows: if uræmic symptoms appear early and advance rapidly, then early nephrotomy, *on the second or third day*, is always indicated; even if the anuria is well tolerated and the symptoms are mild, *one should not wait beyond the fifth day* (Legueu) for the fortunate but very unlikely chance of spontaneous relief.

Finally, one may add that it is never too late to intervene: in the most alarming cases, at the height of uræmic convulsions, some most unexpected recoveries have been obtained. In a medical man on whom Duret[3] operated, there were two attacks of anuria, separated by an interval

[1] Legueu, *Mercredi médical*, 25 juillet, 1894.

[2] Lounneau has reported several cases, amongst others the following: A man 52 years of age, suffering from renal lithiasis, was in his second attack of anuria; he was drowsy, the left kidney was enlarged and tender; there was tenderness along the abdominal course of the ureter, and also at its termination at the base of the bladder. On the fifth day a quantity of gravel was expelled, followed by a large amount of urine. Recovery. (*Soc. de méd. et de chir. de Bordeaux*, 8 juillet, 1898.)

[3] Reported in A. Vailhen's thesis, *De l'intervention chirurgicale dans l'anurie calculeuse*, 1896.

of a few days: the first lasted two days; the second attack was more protracted, and complicated by vomiting and considerable prostration, and finally there was an exceedingly violent convulsive seizure; the face was cyanosed, respiration stertorous, and the pulse feeble and irregular. Nephrotomy was performed forthwith without anæsthesia. The subcutaneous layer of adipose tissue and the fatty capsule of the kidney were enormously thick; the kidney was of the size of two fists, absolutely immobile, and fixed to the vertebral column. Notwithstanding the great depth at which the organ lay, the operator succeeded in making an incision in the convex border, and in introducing his finger into the pelvis, in which two large drainage tubes were then placed. During the night the urine soaked through the dressing, and next day began to pass by the natural channel. The patient recovered, and was ultimately able to resume his professional work.

Chevallier[1] performed nephrotomy on a woman 63 years of age on the fourteenth day of anuria; the patient was in a state of semi-coma and her temperature was subnormal (96·2°), but she recovered.

The results of urgent nephrotomy in cases of calculous ureteral obstruction are naturally very different from those obtained in cancerous anuria, where because of the nature of the primary affection the outcome is always doubtful.

Cancerous Anuria.—Under this heading I wish to speak of the anuria which sometimes occurs as a result of compression of the ureters in cases of cancer of the cervix uteri. Here, the onset is usually insidious, and unattended by any striking symptoms; in other words, the anuria is preceded by oliguria, a period of variable length during which the quantity of urine progressively diminishes.

The complication appears at two different stages of the primary disease and in two very dissimilar forms:—

1. The anuria is merely *a last phase in the evolution of a long recognized and hopeless condition*; the kidneys have been affected for a long time, pyelonephritis is present and progressing; the complete cessation of renal activity only hastens by a little the inevitable termination.

2. The anuria develops *suddenly and unexpectedly* in an apparently healthy woman, and during the examination undertaken to find the cause of the condition the patient is discovered to be affected with cancer of the uterine cervix.

There can be no doubt that the immediate prognosis of nephrotomy is decidedly more favourable in the latter eventuality.

Here again the operation ought to be performed as soon as possible, without delaying on the chance of a spontaneous relief, which is rendered extremely improbable by the nature of the obstruction.

It is often difficult to decide on which kidney to operate. In these cases, the indications provided by an attack of renal colic are lacking. However, on careful examination of the kidney regions, it will generally

[1] Chevallier, *Assoc. franç. d'urol.*, oct., 1896.

be found that the tenderness is more acute, the pain more severe, and the organ larger and placed at a somewhat lower level on one side than on the other; these points are quite sufficient to indicate the side on which the operation must be performed.

Technique of Urgent Nephrotomy.—Nephrotomy in urgent conditions, is, and ought to be, a simple operation: *exposure of the kidney by the lumbar route, incision on the convex border down to the pelvis, and drainage*—that is the whole programme.

Have the patient carefully anæsthetized with chloroform or ether, and placed in good position; he must be laid on the sound side: on the right side if you are operating on the left, with the right thigh extended and the left thigh semi-flexed, with a hard cylindrical pillow placed transversely under and lifting up the right ileocostal space for the purpose of opening out the left ileocostal space, while another thick pillow, resting against the anterior abdominal wall, supports the trunk and prevents it from tilting forwards.

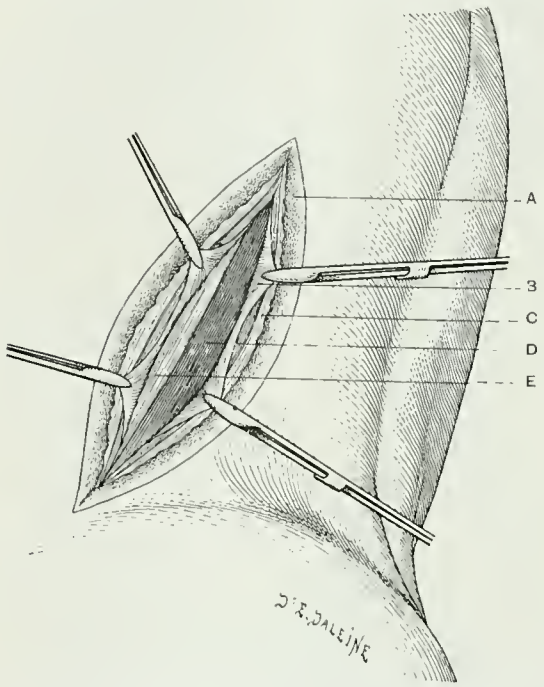

Fig. 24.—Nephrotomy. Incision. (A) Subcutaneous fat. (B) Inner edge of the divided transversalis aponeurosis. (C) The superficial muscular plane. (D) Quadratus lumborum muscle. (E) Deep fibrous layer.

The lumbar region is well exposed from the last ribs to the crest of the ilium, from the spine to the outer limits of the flank. Wash and prepare the whole of this large area, because abundant room and a long incision will be needed, particularly in fat patients.

Make an **oblique incision** beginning over the 12th rib, four finger-breadths from the middle line, at the outer margin of the prominence formed by the erector spinæ muscle and extending downwards and forwards to terminate at the mid-point of the iliac crest. If the opening seems insufficient for reaching a large adherent kidney buried in fat, the lower end of the incision may be extended forwards along the iliac crest, or again, more room may be provided by means of a secondary transverse incision joining the first at the middle of its anterior lip.

Although the opening must sometimes be of enormous size, by making the incision which we have just described, and by going down layer by layer

to the perirenal fat, there is nothing to fear ; one cannot go astray, and must necessarily open into the renal pocket.

Incise the skin, the subcutaneous fatty tissue, the posterior fibres of the external and internal oblique muscles, and the aponeurosis of the transversalis muscle (*Fig.* 24) ; the thin deep fibrous layer is now exposed ; it is sometimes perforated by processes of the underlying perirenal fat, and to the inner side there is *the outer border of the quadratus lumborum*, a valuable and always visible landmark. Apply some forceps to the bleeding inter- and intra-muscular arterioles, displace the quadratus inwards under a broad retractor, and divide the deep fibrous layer.

The perirenal fat now becomes visible ; sometimes it is lax and comparatively scanty, and in its midst the kidney is found at once and readily exposed by a few turns of the finger ; at other times, and more frequently, an enormous mass of fat is present and must be rapidly opened up. Use two pairs of dissecting forceps for tearing open the peripheral layer, which is always comparatively dense, sometimes indeed like a capsule (*Fig.* 25) and, once the way is open, go straight to the kidney.

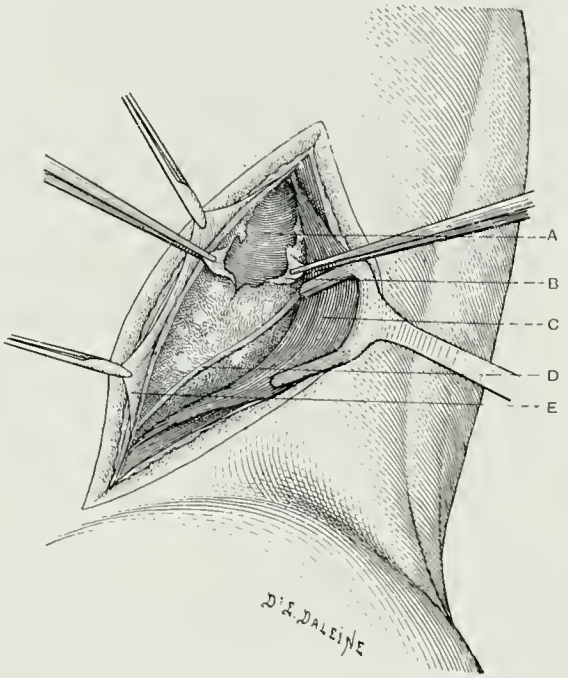

Fig. 25. Nephrotomy. Exposure of the kidney ; opening the fatty capsule. (A) Upper pole of the kidney. (B) Fatty capsule, being separated by two pairs of dissecting forceps. (C) Quadratus lumborum, the outer border drawn inwards. (D) Last dorsal nerve. (E) Aponeurosis of the transversalis muscle.

Usually it is displaced downwards, and is enlarged and congested ; disengage its anterior and posterior surfaces by pushing back the fatty sheath with the fingers, and do all that is possible to free the organ sufficiently to allow it to be brought entirely outside the wound ; devote special care to clearing the upper pole, which is always more fixed than the rest, and endeavour to bring it down by hooking the fingers above it (*Fig.* 26).

With a sufficiently long incision, the edges of the wound well retracted, a kidney of medium size, and a comparatively lax fatty capsule, it is not very difficult to turn the kidney out on to the loin, if the organ has been properly freed and if it is pushed up into the wound by the fist of an assistant

or the free hand of the operator applied on the anterior aspect of the flank. If the kidney is very large, and adherent and embedded in a mass of indurated tissue, do not persist with the attempts to enucleate it at the risk of tearing it; carefully free the convex border, and as much as possible of the two surfaces, and fix the organ in sight at the bottom of the incision by means of a large compress packed around the pedicle while you incise it. The proper place for the incision is along the convex border (*Figs.* 28 & 29); the length of the incision will naturally vary according to the size of the kidney, but will usually be about $1\frac{1}{2}$ or 2 inches. Make the incision with the scalpel; if the organ has been brought outside the wound, fix it between the fingers, which at the same time compress the pedicle; if it has not been possible to do more than draw it to the bottom of the wound, the fixation must be obtained by means of the gauze compress packed in below.

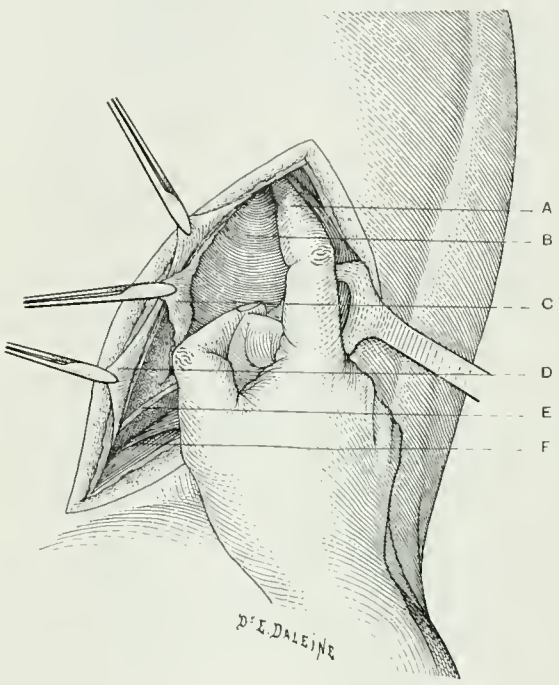

Fig. 26.—Nephrotomy. Extraction of the upper pole of the kidney. (A) Finger separating and pulling down the upper pole. (B) Kidney. (C) Fatty capsule. (D) Aponeurosis of the transversalis. (E) Last dorsal nerve. (F) Outer border of the quadratus lumborum.

Now split the renal tissue right into the pelvis; if the incision has been properly placed along the convex border (*Fig.* 27), there will be very little bleeding, and at any rate, even should the oozing be profuse, it can be easily controlled by compression of the pedicle or of the kidney itself.

Do not expect to see a stream of urine escape; usually there will only be a few spoonfuls of turbid, perhaps purulent fluid.

Pass a finger through the opening in the kidney and *explore the cavity of the pelvis*; calculi will often be felt there, large concretions filling the whole cavity (*Fig.* 30), multiple, irregular branched calculi, penetrating into the calices and into the renal tissue, perhaps masses of impacted gravel. The stones must be extracted; a pair of Kocher's forceps or ordinary pressure-forceps will usually suffice to seize the loose calculi and bring them out; if any stones are embedded in the renal parenchyma or impacted at the outlet of the pelvis, it may be necessary to enlarge the incision before

they can be extracted; in such a case it is advisable to introduce a few points of suture at each extremity of the incision after the extraction.

All this is very simple, and may be summarized as follows: **Open the pelvis through the kidney, empty it and drain it.** This exploration of the pelvis is always worth doing; by means of it and removal of the obstructing calculi, the permeability of the urinary channel may at once be restored in some cases.

A man 68 years of age, operated on by Pousson,[1] had passed no urine for twelve days; he had had numerous attacks of renal colic, chiefly on the right side, and there was no doubt as to the cause of the anuria.

Nephrotomy was performed: six calculi were found in the renal pelvis, three being free in the calices, two large ones embedded in the substance of the kidney, another, the size and shape of a marble, plugged the entrance to the ureter; all six were removed. Four hours later the patient passed, by the urethra, a pint of urine, and 22 pints during the following three days, without including the quantity which was discharged into the dressing.

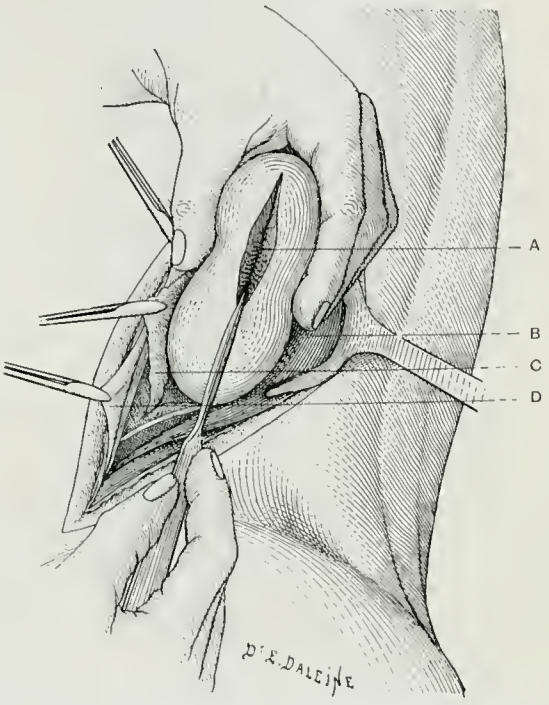

Fig. 27. Nephrotomy. The kidney, delivered through the lumbar wound, is fixed by the left hand and incised on the convex border. (A) Incision on the convex border. (B) Quadratus lumborum. (C) Fatty capsule. (D) Aponeurosis of the transversalis.

Ought we to carry the search for the obstruction any further by exploring the ureter, catheterizing it, or opening it?[2]

[1] Pousson, *Soc. de méd. et de chir. de Bordeaux*, 24 juin, 1898.

[2] In the ureter, a calculus is usually impacted either very high up, or at the lower end close to the bladder. In the former condition the concretion may be felt on palpation of the ureter by way of the lumbar wound, and it may be possible to push the stone up into the renal pelvis and to extract it. A case reported by Legueu may serve as an example: "In the renal pelvis (reached by nephrotomy) I found several friable stones, which were easily extracted. I then attempted to catheterize the ureter. . . . The bougie entered the upper orifice without any difficulty, but was arrested about 1½ inches below the kidney. At that level, by external palpation of the ureter I was able to detect a localized, rounded induration about the size of a bean and feeling like a lymphatic gland. But a metallic sound passed through the kidney and the ureter to the same point gave a definite sensation of a stone. . . . By external pressure on the ureter I was able to push the calculus up into the pelvis, whence I extracted it. A bougie introduced into the ureter could then be passed down into the bladder." Israel also, in a case

As a general rule, in the urgent conditions which we are considering, the answer is, No ; when the kidney has been opened, and its pelvis emptied

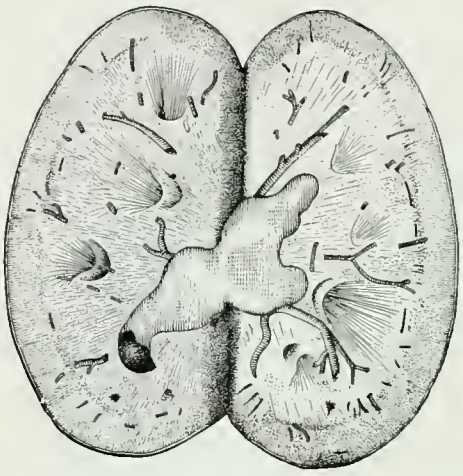

Fig. 28.—Median section of kidney through the convex border showing the comparative absence of large vessels as compared with *Fig.* 29 (Tuffier and Lejars).

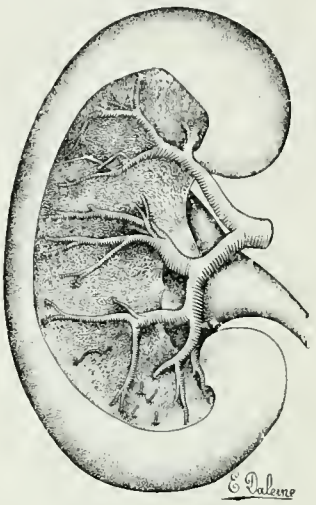

Fig. 29.—Arteries of the kidney running superficially (Tuffier and Lejars).

and drained, the essential object of the operation has been achieved ; moreover, after the urinary obstruction has been relieved, spontaneous expulsion of the calculus has occurred at a more or less remote date in quite a considerable number of cases.

Fig. 30.—Enormous calculus which filled the pelvis and calices (two-thirds natural size).

This happened in a case reported by M. Lucas-Championnière ; [1] nephrotomy had been performed on the third day of anuria ; the left kidney was incised with the thermo-cautery, a stream of fœtid pus and a large quantity of urine escaped, but no calculus

in which a calculus was impacted in the ureter about four inches above the vesical orifice, succeeded in pushing the stone back along the ureter into the pelvis. These are of course very satisfactory results, and ureteral catheterization is undoubtedly a desirable complement of nephrotomy : but some practice is necessary for its satisfactory performance, and if it presents the least difficulty, or in any degree complicates or prolongs the operation, it is much better to limit oneself to meeting the essential indication : *drainage of the pelvis of the kidney*.

[1] This case was published by Demelin in *Ann. des mal. des org. gén.-urin*, t. vi., p. 438. In a case reported by Vignard, of Nantes, a calculus the size of a bean was spontaneously expelled from the ureter forty-eight days after operation, and normal micturition was then re-established. (*Congrès d'urologie*, oct., 1898.)

was found in the pelvis, which was simply drained. On the twenty-fifth day urine was passed by the natural channel; on the thirty-second day a calculus the size of a large pea was removed from the bladder. The lumbar fistula then closed, and complete recovery ensued.

Before leaving this subject, another point requires consideration. Should the kidney be marsupialized? that is to say, should the edges of the renal incision be sutured to the margins of the cutaneous wound? This should be done if the kidney is seriously diseased, transformed into a large pyonephrosis; in such conditions a few sutures attaching the margins of the incision in the kidney to the skin will be very useful in preventing local septic complications (*Fig.* 31).

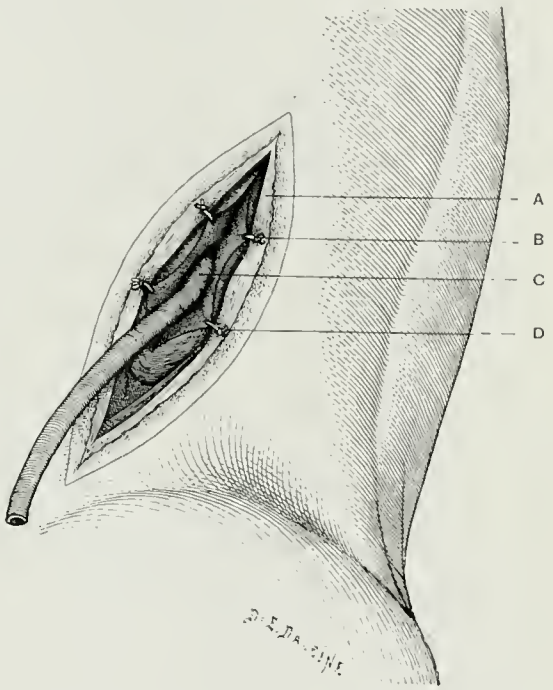

Fig. 31.—Nephrotomy. The opened kidney is fixed to the wall and drained. (A) Musculo-aponeurotic wall. (B, D) Edges of the renal incision united to the wall by several sutures. (C) Drainage tube penetrating to the pelvis.

Excluding these special indications, the best plan is simply to place one large drainage tube, or two of medium size, in the renal pelvis, and to bring the end outside and fix it at the lower angle of the lumbar wound; if there is any oozing, place another tube or a strip of gauze in the kidney pouch, and lastly, suture the extremities of the parietal wound.

In *cancerous anuria* the technique is somewhat simpler, because all that is necessary is to make a short incision along the convexity of the kidney and to place a drainage tube in the pelvis. If thought desirable, the incision along the convex border may be very short, not more than an inch, and the opening completed by pushing the closed blades of a pair of Kocher's forceps through the renal tissue into the pelvis, and then withdrawing them open. Into the channel thus produced a tube is then inserted.

Generally, however, it is better, and does not require any more time, to open the way into the renal pelvis by a free incision, because good drainage is thereby assured. Drainage is, as before, the chief aim of the operation.

I shall merely mention **decapsulation of the kidneys** in nephritis, which may be tried in certain cases where there is considerable diminution in the quantity of urine, hæmaturia, and threatening uræmia.[1] The operation consists in exposing one or both kidneys by the lumbar route, making an incision along the convexity, stripping up the two halves of the capsule, and resecting them.

The patient is anæsthetized and placed on his side with a pillow under the lower iliocostal angle; the usual oblique lumbar incision, about four

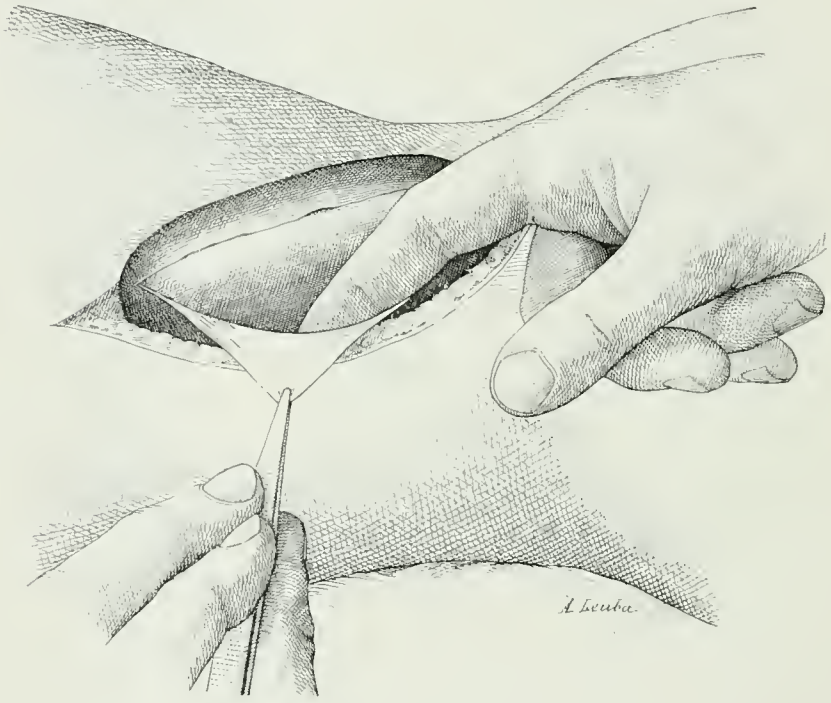

Fig. 32.—Decapsulation of the kidney.

inches in length, is made, and the kidney exposed by detaching the fatty capsule. The fibrous capsule proper is carefully separated with the finger from behind forwards (*Fig.* 32) and excised close to the hilum. The kidney is restored to its position, the wound closed, and the operation repeated on the other side. Sometimes it may happen that the organ is displaced, accessible with difficulty, and cannot be mobilized; or again,

[1] The results of the operation have not been uniform; but in some cases it has been attended by a considerable increase in the quantity of urine, the disappearance of blood, and a more or less durable improvement in the general symptoms. G. M. Edebohls, of New York, who first, in 1898, performed this operation, reported 72 cases in 1904, the decapsulation having in most instances been performed on both sides. (*The Surgical treatment of Bright's Disease.* New York, 1904.)

that the fibrous capsule is adherent to the parenchyma ; in the former circumstances the decortication must be performed without disturbing the position of the organ ; in the latter, after section of the capsule, the two portions must be separated very slowly and carefully. Any rough handling must be avoided, for the parenchyma is often very friable and may readily be torn.

URINARY EXTRAVASATION.

A man some fifty years of age was brought to us with the following history : he had suffered for a long time with a urethral stricture, and for some weeks micturition had been attended with great and increasing difficulty ; six hours before admission, during a forced effort to pass water, he had suddenly felt a sort of cracking, followed by a relief of tension ; since then not a drop of urine had escaped from the urethra.

We found the perineum, the scrotum, and the penis already enormously swollen. Between the separated thighs the scrotum formed a swelling the size of two fists, like a large ball covered with smooth, red, and shining skin, on the front of which lay the penis, thrice its natural size ; the redness and œdema extended in front on to the pubes and behind into the perineum, there forming a prominent, rounded swelling, which shaded off on either side into the neighbouring tissues. The whole of this large area gave the same sensation of tense, œdematous infiltration ; nowhere was it fluctuating.

Micturition was impossible ; the patient was pale and anxious-looking, shaken by frequently repeated shivers ; the temperature was high (102°–103°), the pulse rapid and feeble, the tongue dry and white ; in fact, all the signs of fast advancing infection were present.

This case is a typical example of the way in which extravasation of urine, in its most common form, usually presents itself, though of course with some variations, dependent on the date of the accident, the rapidity of the infiltration, and the virulence of the infection. In some cases, even of recent date and with only a moderate amount of infiltration, one may find general symptoms of an exceptionally alarming character, which from the first point to an almost inevitably fatal issue ; in others the infiltrated areas very speedily present indications of diffuse gangrenous inflammation, the scrotum, penis and perineum being stippled with small, blackish, necrotic patches. At whatever stage the case comes under observation, the treatment is the same and is urgently necessary.

Make no attempt to pass a catheter. Waste no time in making superficial, inadequate incisions in the most œdematous areas ; **go to the perineum at once.**

Have the patient placed and secured in the lithotomy position (*Fig.* 35), wash the whole region thoroughly and quickly with soap and water, then have the scrotum raised to expose the perineum, and proceed to the operation. No fluctuation can be felt ; there is no apparent localized accumulation of fluid ; but it is always present nevertheless, and always

in the perineum. And it is in the perineum that the opening must be made, *without any other guide than the median raphe;* but that guide is quite sufficient.

Take the thermo-cautery and **make an incision in the median raphe, and steadily deepen it, always keeping to the middle line, until a jet of urine and pus escapes.** It may be necessary to go to what seems a very considerable depth, an inch, an inch and a half, two inches, or even more, into the thickened and swollen perineum; no matter, keep steadily to the middle line, and deepen the incision without hesitation till the fluid is reached.

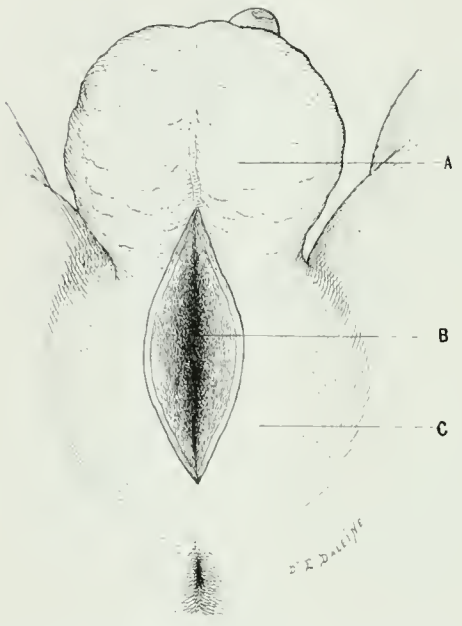

Fig. 33.—Median perineal incision for extravasation of urine. (A) Swollen scrotum. (B) Perineal incision. (C) Perineal swelling.

With the cautery knife at a red heat make the incision from before backwards, from the root of the scrotum to a finger's breadth in front of the anus (*Fig.* 33), and with long regular sweeps divide the thick greyish-black layer formed by the infiltrated perineal tissues, in the midst of which nothing can be recognized; there is no need to recognize anything; if the median plane is strictly adhered to, nothing of importance will be injured; no vessels will be encountered, and the focus from which the extravasation is spreading must necessarily be reached.

The urine and pus are sometimes expelled with considerable force, inundating the table and the operator, but do not expect always to meet with a large quantity of fluid; the essential point is to open a cavity filled with pus and urine; when that has been done the chief object of the operation has been achieved.

However, it is necessary to enlarge the deep part of the channel so that the drainage may be as free as possible, and before laying aside the cautery, make drainage incisions in the scrotum, on the sides of the penis, and on the pubic region, always parallel to the long axis of the body, and sufficiently separated (two inches) to avoid any risk of gangrene of the intervening bridges of tissue; if the swelling is not very great, two or three long pubio-scrotal incisions and a number of scattered punctures, made with the cautery point at a red heat, will provide the necessary ways of escape for the extravasated fluid; on the penis in particular, punctures

are always to be preferred, as they do not give rise to subsequent troublesome contractions. While giving due attention to this important point, the number of drainage incisions and punctures must be amply sufficient to allow of free escape of the fluids.

Now bathe freely the whole operation area—the perineal incision and all the drainage openings which have just been made—with warm boiled water ; express the sanious fluid, and also excise the sloughs if the condition has already reached the stage of gangrene ; but as a general rule do not try to do too much ; if the perineum has been freely opened up, and a sufficient number of secondary incisions have been made, the fluids and the sloughs will be eliminated without difficulty, and the ultimate results will very often exceed all expectation.

No form of drainage is of any value. Leave the incisions widely open, and cover the whole area with a thick layer of moist gauze, and over that again a thick mass of cotton-wool, secured in position by a T-bandage.

This operation is often attended by most satisfactory results, and causes the abrupt disappearance of all symptoms of infection. For the first few days the patient will be allowed to pass all his urine by the perineal opening ; no attempt should be made to pass a catheter, nor should a catheter be tied into the bladder until a later date, when the crisis is past and the swelling of the tissues has disappeared.

If a thermo-cautery is not available, the incision can be made quite well with an ordinary scalpel, and if it keeps strictly to the middle line, it will give rise to only a negligible amount of bleeding ; but the thermo-cautery is always to be preferred, because it not only prevents loss of blood, but also exercises a special and salutary action on the infiltrated and devitalized tissues.

Another form of urinary infiltration is that which succeeds ruptures of the deep urethra **within the superior perineal compartment** ; it is much less apparent in its initial stages, and invades the cellular tissue of the pelvis, ultimately showing itself in the ischiorectal fossæ or in the hypogastric region.

The visible lesions are very deceptive ; they indicate most inadequately the nature and extent of the deep-lying conditions ; the difficulty in providing free drainage, the commonly very extensive diffusion of the septic urine, the late recognition of the nature of the primary accident, and the consequent advanced stage of infection—all these tend to make the prognosis in cases of urinary extravasation in the deep perineal compartment very bad indeed.

Case 6.—An old man, 65 years of age, was brought to the Beaujon Hospital with a diagnosis of diffuse abscess of the abdominal wall. The patient was in very bad condition, and could scarcely answer the questions put to him, but finally we learnt that the symptoms had appeared four or five days previously, and that since then he had passed hardly any urine, and the swelling in the hypogastric region had slowly increased.

The whole of the hypogastrium was occupied by a widespread, thick swelling of a bright red colour, which gave to the hand a sensation of hard œdema, and extended below over the pubes to the root of the penis. There

was no swelling of the scrotum or perineum; the ischiorectal fossæ presented their normal appearance. The pulse was very weak, the temperature below 98°, and the patient looked very ill.

Forthwith I made an incision in the middle line above the pubes with the thermo-cautery, and after having traversed a layer of tissue about two inches in thickness, infiltrated with sanious fluid, smelling strongly of urine, I opened into an irregular cavity, with greyish sloughing walls and full of foul urine, which occupied the retropubic space and extended downwards into the pelvis to a large area having all the appearance of a diffuse gangrenous abscess. I cleansed and drained the huge cavity as well as possible in view of the alarming symptoms, which necessitated the utmost expedition. However, the patient died during the night.

In this case **the deep-seated extravasation had shown itself in the hypogastric region only**; more frequently, however, **it is around the rectum, in the ischiorectal fossæ**, that the red and œdematous swelling first appears, and it is these regions which must first of all be explored and incised.

As a matter of fact, as we have already said, the peculiar gravity of this form depends on the difficulty which is experienced in recognizing it at an early stage, and on the diffuse gangrenous pelvic cellulitis which is already in existence when the first external signs appear; further, if micturition is not absolutely impossible, and if the character of the rupture is such as to permit a small quantity of urine to escape by the natural channel, then all the conditions which tend to a prolongation of the dangerous period of doubt and expectancy are present.

It must be remembered that the extravasation is by no means always confined to the definite areas described by anatomists, nor do the lesions invariably present themselves in one or other of the two typical forms which we have just described; the general principle applies equally to all cases, however; as soon as an area of infiltration is recognized, wherever it is situated, **it must be incised without delay**, care being taken to work towards the urethra and to open a drainage channel right down to the site of the primary lesion.

In deep-seated infiltrations, in the upper perineal compartment or intrapelvic, cystostomy, followed by syphon drainage of the bladder, is sometimes useful in cases where the urethral lesion is in such an inaccessible position that to reach it and at the same time provide adequate direct drainage would be a very difficult matter. (See CYSTOSTOMY.)

URINARY ABSCESS.

A few brief remarks will suffice here, as the technique of the operative measures follows the lines we have just laid down for dealing with diffuse extravasation of urine.

In the middle line of the perineum a rounded or oval swelling is found, lying over and adherent to the urethra, hard, thick, and doubtfully fluctuating, or perhaps at a somewhat more advanced stage, softened, red, and

œdematous, extending to a variable distance laterally or towards the front, but always showing its maximum prominence in or close to the median line and ensheathing the urethra. The patient suffers from urethral stricture, and has for long had considerable difficulty with micturition, while during the last few days or weeks the difficulty has become markedly greater.

The swelling is **a urinary abscess**; the seat, the appearance, the consistence, and the evolution of the swelling, together with the patient's history, makes the diagnosis perfectly evident.

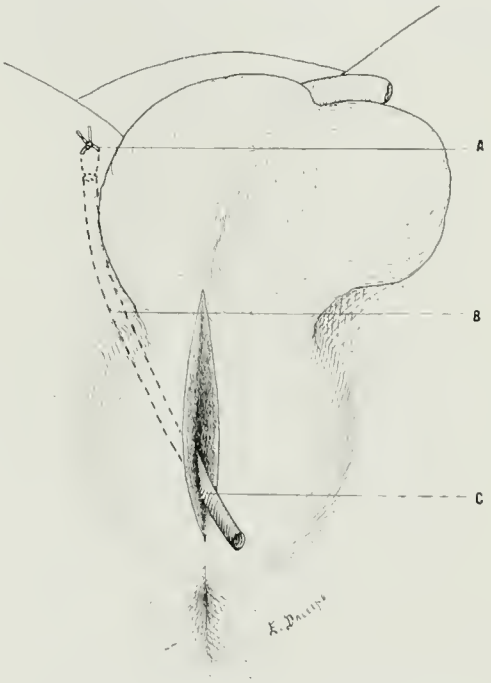

Fig. 34.—Incision and drainage of a urinary abscess. (A) Upper end of the tube fixed right at the bottom of the diverticulum. (B) Supero-external extension of the abscess. (C) Lower end of the tube emerging from the median perineal incision.

Incise the swelling at once; do not wait till superficial fluctuation appears—this wise rule dates from the time of J. L. Petit. Make the incision in the middle line, along the raphe, from the root of the scrotum to the anus, with long sweeps of the knife from before backwards, without troubling about the thickness of tissue that has to be cut through; there is pus at the centre of the brawny swelling, and the incision must be deepened until the cavity is reached.

The quantity of pus is always greater than had been expected, and is sometimes mixed with urine; once the cavity is opened, explore it carefully with the finger, behind, in front, and laterally. Remember that posteriorly there is not uncommonly an extension which ascends in front of the rectum; therefore carry the incision right back to the anal sphincter, so as to lay bare the track if one exists.

Laterally, the pus sometimes invades one or both ischiorectal fossæ; if the extension is large, make a free counter-opening into it, and drain with a large-sized tube.

It is, however, **above and externally along the ischiopubic rami and over the corpora cavernosa** that the greatest extension is most frequently found, and these supero-external diverticula frequently give rise to most obstinate sinuses and fistulæ. Do not fail, therefore, to drain them right from the bottom in the way recommended by Professor Guyon (*Fig.* 34).

To do that, make a counter-opening at the deepest part of the diverticulum by passing the finger to the bottom of the channel, making an incision over its tip, bringing the upper end of the drainage tube out through the opening, and securing it in position by a safety pin passed through it. Sometimes it may be simpler to attach a double thread to the end of the drainage tube, and then to pass a long needle from above, through the skin, over the bottom of the channel, down the channel, and out through the perineal wound; then, after threading one of the ends through the eye of the needle, to withdraw the latter; by this manœuvre the thread will be carried along the channel and out through the skin; the second thread is passed in a similar manner, and then, by pulling on the two threads, the tube is drawn into a good position at the bottom of the diverticulum, and secured there by knotting the two ends of the thread together on the skin. The drainage tube must be left in position until the separated skin has recovered its attachment to the underlying tissues.

When the abscess is very extensive, large and multiple drainage openings are required; this is the best means of shortening the time necessary for cicatrization, which is always long. In some cases the urinary abscess presents itself in the form of a *small, rounded, and fluctuating swelling* situated at the root or along the under surface of the penis; it should, however, like the larger abscesses, be recognized and incised at once; nothing more is needed than a touch with the point of the knife and the introduction of a small tube.

Or again, in a patient with an old stricture, a small, definitely localized swelling may be found, softened at the centre but with a hard and callous periphery; it is a chronic abscess, and cannot be cured by simple incision and drainage, which would merely result in a permanent urethral fistula.

The best plan is to take advantage of the limited extent and the definite localization of the abscess, and **to excise it like a tumour.**[1]

Make an incision, first of all, into the centre of the mass and, after having ascertained that the cavity has no long prolongations, circumscribe the nodule by two curved incisions and extirpate it completely.

Usually, and particularly in the urgent conditions which we are considering, one will confine oneself to dealing with the abscess. That is, of course, only the primary step in the treatment. A little later,[2] when the suppurating area is in a clean, healthy condition, the stricture must be treated.

TRAUMATIC RUPTURES OF THE URETHRA.

Urinary infiltration and infection of the tissues on the one hand, and *subsequent urethral stricture* on the other, are the conditions to be feared and guarded against in every case of rupture of the urethra.

[1] Hortelour, Traitement des abcès urineux. *Ann. des mal. des org. gén.-urin.*, oct., 1891.

[2] From six to twenty days after the incision of the abscess (Guyon).

The practical conclusions are easily drawn: to provide a free channel of escape for the urine; to drain and disinfect the focus of injury, and, if possible, to re-establish the continuity of the canal. These measures are not all of equal importance, nor indeed are they always equally possible, but vary with the gravity of the lesions and the stage at which operation is performed. It is therefore necessary to classify the various clinical possibilities in definite groups.

We shall consider, in the following order: (1) *The common ruptures of the perineo-bulbar portion or of the membranous portion of the urethra, without fracture of the pelvis;* (2) *Ruptures of the deep urethra, with fracture of the pelvis;* (3) *Ruptures of the penile urethra.*

I.—RUPTURES OF THE PERINEO-BULBAR URETHRA.

1. Incomplete Ruptures.—A man 56 years of age was admitted to La Pitié on June 14th, 1894. Two days before he had received a violent kick on the perineum; the pain had been very severe, and had been followed after an interval of a quarter of an hour by profuse bleeding from the meatus. At the end of some hours the patient had passed urine, and since then micturition had been performed spontaneously, though always with some difficulty; the passage of the urine provoked intense smarting pain in the canal, and at each repetition a little blood escaped before the stream. There was intense ecchymosis of the scrotum, and the discoloration extended over the perineum, but no swelling whatever was present in the latter situation. In the middle line over the bulbar portion of the urethra there was a very tender spot, but nothing more.

What was to be done? Nothing, naturally, **and particularly no catheterization**; the patient could empty his bladder, and there was no sign of extravasation of urine. I contented myself with having the urethra syringed out several times daily with warm boiled water. By the end of a week, all bleeding had ceased, and micturition could be performed painlessly.

This is a typical case of **incomplete rupture**; the patient is able to pass urine, though with some trouble and some pain, but sufficiently to empty the bladder, and there is no perineal swelling.

Even when a rupture is limited to the mucosa, the hæmorrhage from the meatus may still sometimes be very profuse; one can therefore draw no inference as to the gravity of the urethral lesion from the amount of bleeding, particularly from the bleeding which occurs immediately after the accident. Further, micturition may be suspended for some hours merely from the shock of the injury; therefore, if the patient is seen very shortly after the receipt of the injury, it is a wise practice to wait some little time, and not immediately to try to pass a catheter; wait to see if any perineal swelling appears, and if not, then wait a little longer to see if the bladder becomes distended and can be felt in the hypogastrium, while fruitless attempts at micturition show that the channel is obstructed, or that the functional mechanism is temporarily thrown out of gear.

These incomplete ruptures occur not infrequently after blows of moderate severity or which strike obliquely against the surface of the perineum; of late years a considerable number of instances has been recorded resulting from bicycle accidents in which the injury has been produced by a sudden jolt on the saddle or the pommel of the saddle, or by an actual fall.

In such conditions, if retention of urine is present, or if micturition, though possible during the first days, becomes progressively more difficult and finally impossible, catheterization is indicated; the operation must be conducted aseptically, carefully, and methodically, with a soft catheter. An instrument of medium size (No. 8 or 9 English) should be first tried, because spasm plays an important part in the mechanism of these retentions, which cannot be altogether ascribed to actual obstruction.

The catheter should be passed gently **along the upper wall of the urethra**; if, after a few gentle attempts, it is found that only a small-sized instrument can be introduced, it may be left in position, and the somewhat inadequate drainage provided by its small channel be reinforced by the addition of a syphoning apparatus (see later); but in such conditions the patient must be kept under the closest observation, and on the first sign of any perineal swelling, external urethrotomy should be performed without delay. If no complications supervene, the first catheter should be replaced as soon as possible by one of a larger size.

This method is often successful; it is simple, and is the rational plan in cases of *partial laceration of the urethral wall*, and it hastens the healing processes. Its application, however, is limited by the following reservations: when a ruptured urethra does not permit the easy passage of the catheter, it must not be treated as if it were a strictured urethra, by persistent attempts to pass small-sized catheters or filiform bougies; there is a recent gaping solution of continuity, ready to allow infiltration of urine into the peri-urethral tissues. In such a case, to content oneself with leaving a catheter of insufficient calibre to ensure adequate drainage is simply to invite the complications which result from urinary infiltration, and which indeed occur only too often even when a large catheter is in the bladder. After some lapse of time, and particularly when syphonage has not been employed, the urine begins to pass between the catheter and the walls of the urethra, and escapes through the rupture into the tissues.

2. Interstitial Ruptures.—This is another class of ruptures in which catheterization finds legitimate indications.

For example, a young man was admitted to the Beaujon Hospital with the following history: on the previous day he had received a violent kick on the perineum; he had lost no blood by the meatus, but micturition was impossible and the bladder was distended. The perineal tissues behind the scrotum were deeply ecchymosed, but there was no swelling whatever; palpation caused acute pain in the bruised area, and the perineal urethra felt thickened and hard.

An attempt to pass a soft rubber catheter was unsuccessful, but caused

no bleeding; I succeeded, however, in passing a flexible gum catheter (No. 5 English) without injuring the urethral mucosa, and the bladder was then able to empty itself slowly. Next day a No. 6 catheter was introduced, and some days later a soft catheter, No. 8. Finally natural micturition became possible, and by the end of three weeks the canal had recovered its normal calibre.

This was a very simple case, and catheterization is by no means always so easy; **there is indeed a very real danger of wounding the mucous membrane, and thus opening into the intraparietal hæmatoma**; if the catheter is left in the urethra, a similar accident may result from necrosis and ulceration of the swollen and compressed mucosa, and the rupture thus *becoming penetrating* is exposed to the complications of which we have already spoken.

Therefore, when the initial catheterization presents serious difficulty, it is better to empty the bladder **by hypogastric puncture**, and to defer any further attempts to introduce a catheter for a day or two, while holding oneself in readiness to perform **external urethrotomy on the first sign of any perineal swelling.**

3. Complete Rupture.—In such a case, indicated by **hæmorrhage from the meatus, swelling in the perineum, and inability to micturate,** there can be no doubt as to the proper line of treatment: **no attempt should ever be made to pass a catheter; a perineal incision must be made forthwith.**

To try first of all to introduce a catheter is almost instinctive, and in reading the accounts of the reported cases one meets again and again with the same story in almost the same terms: catheterization has been attempted without success, and after more or less prolonged efforts it has been found necessary to perform external urethrotomy. Further, experience teaches that these attempts to pass a catheter almost invariably fail; also that *they always complicate and aggravate the urethral lesions*, and that even if a small-sized catheter should in the end be introduced into the bladder, its presence is unable to prevent the development of dangerous complications; the rational treatment, external urethrotomy, will simply be delayed by the initial success, and will ultimately be required under much more difficult and dangerous conditions.

Primary delay, with subsequent difficulties, is the only result to be expected in the great majority of cases from successful—so-called—catheterization.

A man falls astride a metal bar; he is seen some hours later. *He has lost a considerable quantity of blood from the urethra*, and the lips of the meatus are glued together by dried clots; *he has passed no urine since the accident*; he has felt intense desire to do so, but his efforts have been ineffectual, although *the bladder is distended*; the scrotum is discoloured with effused blood, and on raising it the ecchymosis is observed to extend backwards as far as the anus; in the middle line of the perineum there is *a thick, rounded antero-posterior swelling*, which in front extends along the urethra, surrounding it and apparently continuous with it.

Do not expect always to meet with a very large and prominent perineal swelling, and do not forget that here again the deep lesions are as a rule more serious than the external appearances seem to indicate. *The peri-urethral hæmatoma* alone is a sufficient indication of extensive injury of the wall of the canal and of the need for early operation. The sooner this is undertaken, the better will the operator be able to do it.

The following is a striking illustration :

Case 7.—The patient was a man some 40 years of age, who had not fallen in the usual manner astride, but in the first place on his side, and had then been thrown violently backwards. He was admitted into my hospital service in the evening : the hæmorrhage from the urethra had been severe, and still continued, but there was no perineal swelling. The bladder was emptied by suprapubic puncture. Next morning, micturition was still impossible, and the bladder was distended ; but the perineum, though ecchymosed, was flat and otherwise normal in appearance. After a short and unsuccessful attempt to pass a catheter, I made a median perineal incision and exposed an extensive sheet of effused blood extending from the root of the scrotum to the anus and laterally to the buttocks, separating the teguments from the deep tissues.

After clearing away the blood and clots, I recognized the anterior end of the torn urethra, rendered evident by the catheter which I had first introduced, and behind it a large tear, a sort of crushing of the wall of the canal, involving a length of about 1¼ inches, while above, a narrow strip represented the untorn portion of the upper wall. By following this strip of tissue with the tip of a flexible gum catheter (No. 8 English) I had the good fortune to penetrate at once into the posterior end, which corresponded to the first part of the membranous urethra ; the catheter being directed almost directly upwards, entered the bladder and the urine began to escape.

By means of the soft rubber catheter first introduced, I drew the proximal end of my gum catheter along the anterior urethra and out at the meatus. The lacerated edges of the torn urethra were then brought together as well as possible by some interrupted catgut sutures, the overlying subcutaneous tissues were united by a continuous suture, and the skin wound partly closed ; two small drainage tubes and a strip of aseptic gauze were left in the wound. Recovery ensued without any fistula.

Technique of External Urethrotomy.—Be careful to provide everything likely to be required for dealing with whatever lesions may be found ; have soft rubber catheters of different sizes, fine curved suture needles or Reverdin's intestinal needle, silk Nos. 0 and 00, catgut Nos. 00, 0, and 2, and silkworm gut.

Either general or local anæsthesia may be employed, but except in some extremely urgent cases where the operation must simply be limited to a perineal incision, or when contraindicated by any special conditions, general anæsthesia by chloroform or ether is to be preferred, because it greatly facilitates the operation and allows it to be carried out more satisfactorily.

The patient is placed in the lithotomy position and maintained in it by one or other of the methods already described (*Fig.* 35) ; the scrotum and perineum are shaved, washed with soap and water, and disinfected with the greatest care. Then a soft catheter is introduced into the urethra and slipped down to the seat of obstruction, while its proximal end is held up over the lower part of the abdomen along with the penis and scrotum.

Make a longitudinal median incision in the raphe, extending in front and behind beyond the limits of the perineal swelling, in front encroaching on the posterior part of the scrotum.

Immediately under the skin there will sometimes be found a space filled with blood and clots; more often, however, it will be necessary to divide *a second plane of tissue*—a fibrous layer, more or less discoloured and stretched by the underlying blood—the *superficial perineal fascia* (Colles' fascia). All this is very simple, and can be summarized in a sentence: **go at once down to the clots.** Remove the clots with the fingers and swabs, cleanse the cavity carefully, and then investigate the conditions. At the anterior angle of the wound the tip of the catheter will be seen; it

Fig. 35.—Lithotomy position.

serves as a guide to the urethra. The rupture may in different cases present very different characters, on which the subsequent steps to a great extent depend.

A. **Rupture of the Inferior Wall Only.**—It may happen that the lower wall alone is involved; the margins of the rupture are more or less retracted, but **the upper wall,** though sometimes reduced to a narrow strip, still **stretches like a bridge from one end to the other** (*Fig* 36).

Endeavour to make use of this connecting bridge by slipping the tip of the catheter along it; to do this, apply the left index finger longitudinally over the gap from one end of the torn urethra to the other, so completing the canal, and push the catheter along this artificial inferior wall towards

the posterior orifice, in which by this plan it may sometimes be fortunate enough to engage at once. The chief object of the operation is then accomplished, and it only remains to suture the rupture if the local conditions are adapted for repair.

Frequently, however, this simple manœuvre fails. In that case proceed to draw a sufficient length of the catheter into the perineal wound to allow of its being grasped and handled easily, and direct the tip towards the position of the posterior orifice.

The intact portion of the upper wall will necessarily conduct the catheter to the orifice; with a pair of dissecting forceps, a director, or a probe, turn aside the fringes of the torn wall which hide the orifice, and between or below them seek for the opening with the tip of the catheter, but without using any force or roughness; if in the proper channel the instrument will slip in easily; if any resistance is met with, withdraw

Fig. 36.—Rupture of the lower wall of the urethra. A catheter has been introduced into the canal (diagrammatic).

Fig. 37.—Rupture of the lower wall of the urethra. Closure with interrupted sutures (diagrammatic.)

the catheter and start afresh. It is a matter of patience and dexterity, not of chance; besides, in these cases the step is never so difficult as after a total rupture.

When the catheter has entered the bladder in ordinary cases, the next step is **suture the urethra**, at least when the operation has not been too long delayed and the tissues are not too much infiltrated, infected, and too friable.

Here, again, the unruptured strip of the upper wall is of great assistance, and facilitates the approximation and suturing of the two ends. Pass a series of antero-posterior sutures of fine catgut or silk, spaced at intervals of an eighth to a twelfth of an inch, in the thickness of the edges of the urethral wound, without traversing the mucous membrane; tie the lateral sutures first, working towards the middle line on the under-surface, where the separation is greatest; tie them gently to avoid tearing through the tissues, but sufficiently tight to bring the edges in close contact (*Fig.* 37).

If the perineal tissues are in a healthy condition, they should now be sutured in two layers, musculo-aponeurotic and cutaneous, in the manner already described; if, however, the appearance of the tissues is not satisfactory, leave the wound widely open (see later).

B. **Complete Rupture; Separation of the Two Ends.**—The operation is always more troublesome, and success less certain, when the urethra is torn completely across.

The perineum is incised, the underlying area widely exposed and cleared of clots, blood, and urine; in the depths of the wound you can see

no sign of the urethra; it is completely divided and the two ends have retracted.

There is no difficulty in finding *the anterior end*: by pushing the catheter, which had been previously placed in the urethra, a little further in, its end will appear in the wound and indicate the position of the orifice. *The discovery of the posterior end* is, however, a very different matter, as it often retracts very far backwards and is frayed out, plugged with clot, and unrecognizable.

Begin by making a careful and systematic examination of the posterior part of the wound; go over the whole area with a director, and explore each little orifice, each depression, each little reddish nodule: if the instrument enters and one can see the smooth surface of the mucous membrane and the lumen of a canal, seize the margin of the opening[1] and try to introduce the tip of the catheter (*Fig.* 38), which will slip in without the least trouble if it is in the proper channel.

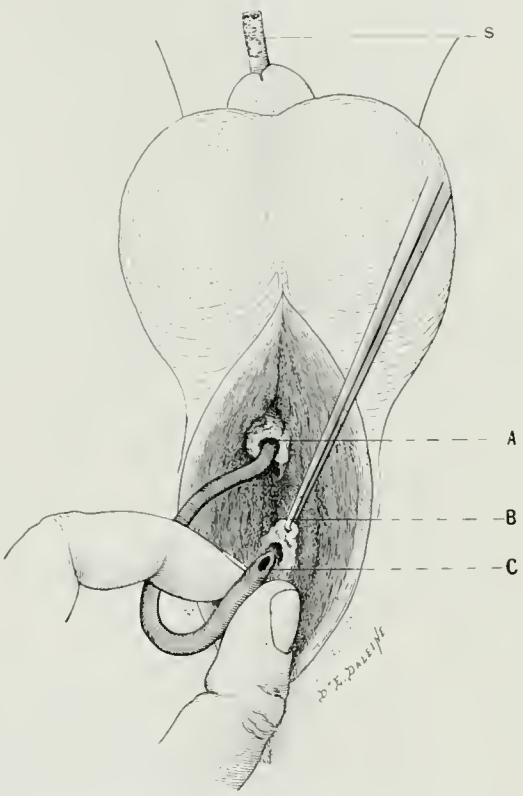

Fig. 38.—Complete rupture of the perineal urethra. Catheterization of the posterior end. (S) Catheter introduced by the meatus. (A) Anterior end with catheter emerging from it. (B) Orifice of posterior end, held by dissecting forceps. (C) Tip of catheter being insinuated into the posterior end.

A little urine escaping drop by drop from the vesical end of the urethra is a valuable guide; if the patient is not under the influence of a general anæsthetic, some voluntary attempts at micturition may produce the desired result; an assistant can often be of considerable assistance by depressing the hypogastric region or by pushing forward the posterior urethra with a finger introduced into the rectum.

If the channel cannot be found, the incision should be prolonged backwards (without ever involving the anal sphincter, however), or more

[1] Be careful, however, to avoid causing any displacement of the orifice: the forceps must only be used to open it by raising the upper lip: two traction threads, introduced at opposite points in the upper and lower walls, and held equally taut, are to be preferred.

room may be provided by means of an additional **transverse, prerectal incision,** a practice which is particularly to be recommended, as we shall presently have cause to mention, when dealing with ruptures of the deep membranous urethra.

The posterior end is found.—Let us suppose that the posterior end of the urethra has been found and a catheter passed along it into the bladder.

Here again, when dealing with quite recent injuries, if the two ends can be approximated with comparative facility, and if the edges of the rupture are fairly regular, not being too much frayed and lacerated, immediate suture is good practice. Of course, suture of the urethra cannot be considered as a necessary procedure, and unless the conditions are altogether favourable it will be better not to attempt it; moreover, in these cases immediate operative success is far from being a guarantee of a permanently satisfactory functional result, for amongst patients who can be followed up it is found that secondary strictures are common.

It is well to be aware of these facts; but still we do not think that the possibility of ultimate failure is sufficient reason for refraining from suture in all cases. The first step is to *bring the two ends in contact* by a series of tension sutures, and afterwards to complete the union by a sufficient number of adjusting sutures. Therefore, pass three or four fine but strong threads through each end, each thread including a good thickness of the wall in its grasp; draw the posterior end of the urethra forwards, and hold it in contact with the anterior end by means of dissecting forceps; tie this first row of sutures gently, so fixing the two portions of the tube in position; these tension sutures are particularly necessary in the upper wall of the urethra; the remaining work is greatly facilitated once they have been passed and tied, and the closure of the urethra around the catheter is completed by some antero-posterior sutures, including as much as possible of the thickness of the wall without traversing the mucosa (*Plate II*).

If rendered necessary by the thinness and friability of the urethra, the preliminary tension sutures may be passed through the whole thickness of its wall without interfering with an ultimately successful result, as is shown by the following case—amongst others—of Lennander's.[1]

The patient was a man 46 years of age, who had sustained a violent perineal contusion against the back wheel in a bicycle accident. He tried to urinate, and passed nothing but blood. Next morning his doctor made unsuccessful attempts to introduce catheters of various sizes into the bladder. In the evening the patient was admitted to the Upsala clinique, and at 10 p.m. an operation was performed under ether anæsthesia.

[1] Lennander, Ueber die Behandlung der Ruptur der hinteren Harnröhre mit vier Fällen von Ruptur der Pars membranacea, darunter eine Fahrradverletzung. *Arch. f. klin. Chir.*, 1897, Bd. xliv., 3, p. 479.

Plate II.—**Rupture of the urethra, suture of the two ends.** A catheter has been passed into the canal; the urethral mucosa is stretched by forceps, while the needle traverses the extra-mucous coat; the first suture on either side is already tied.

RUPTURE OF THE URETHRA: SUTURE OF THE TWO ENDS

A median incision in the greatly swollen perineum opened at once into a large cavity full of blood and urine. The anterior end of the ruptured urethra was readily discovered by the introduction of a catheter by the meatus; the posterior orifice was found on the summit of a small conical nodule which corresponded to the apex of the prostate. The two ends were separated by an interval of at least $1\frac{1}{4}$ inches.

With some difficulty the two portions of the upper wall of the canal were united by means of three sutures of No. 2 catgut, which were passed through the whole thickness of the wall and tied within the urethra. A No. 8 (English) catheter was then passed down the whole length of the urethra into the bladder and fixed to the prepuce by some sutures of silkworm gut. The lower wall of the urethra was united over the catheter by three silkworm-gut sutures which did not penetrate the mucous membrane. The cavity was packed with iodoform gauze, the whole wound left widely open, and the catheter attached to a syphon apparatus. An uncomplicated recovery followed, the urethra uniting by first intention; the catheter was removed on the twentieth day, and normal micturition was speedily restored.

It will very seldom be advisable to **close the urethro-perineal wound completely.** It is, however quite legitimate treatment when the operation has been undertaken at a very early stage, when the focus is of limited extent and contains only clots, or at most very little urine, and when there is not much stripping up of tissue planes. After the urethra has been carefully united by a sufficient number of extra-mucous interrupted sutures, the musculo-fibrous perineal tissues will be sutured in two layers if possible by the same continuous suture, continued from one plane to the other, the better to consolidate all the layers and to obliterate all dead spaces. The cutaneous wound is finally closed without drainage.

But if the peri-urethral tissues are found infiltrated and stripped up, drainage must be employed, a tube being placed in contact with the sutured urethra, and the overlying tissues only partially closed, or even left widely open and packed with aseptic gauze.

If the rupture is associated with wide separation, and the retracted posterior end can only be brought forward with great difficulty, one may simply be content with the perineal incision, which by providing a free escape for the extravasated fluids, meets the immediate indications; but should both ends have been found, it is worth while employing the plan recommended by MM. Guyon and Legueu.[1]

The two urethral orifices are attached to the perineal wound, in the same way as the two ends of intestine are fixed to the skin after some resections for gangrenous hernia, etc.; in other words, the margins of the

[1] Legueu. De la réparation en deux temps des pertes de substance traumatiques ou opératoires de l'urétre périnéal. *Bull. Soc. de Chir.*, 1906, t. 32, p. 816. See also Pasteau et Iselin. La réfection de l'urètre périnéal dans les traumatismes graves du périnée, etc. *Ann. des mal. des org. génito-urin.*, 1906.

two orifices are attached separately to the cutaneous edges of the perineal wound by a series of interrupted sutures of fine catgut (*Figs.* 39, 40). No catheter is placed in the bladder; all the urine is allowed to escape freely by the perineum; healing takes place gradually, until finally there only remains an elongated fistula with soft, supple margins, in the centre of the perineum. The lower wall of the urethra can then be restored by a comparatively simple plastic operation: a square or rectangular cutaneous flap is cut on one side of the fistula, the left for example, dissected up, and turned over from without inwards around its base, which corresponds to the left margin of the fistula; on the right side a second flap is cut with its base externally, dissected up and applied over the first, raw surface to raw surface, and sutured in position in the manner shown in *Fig.* 41. In this way a new inferior urethral wall is formed by the two cutaneous flaps. A little touching up is sometimes required in front and behind, but complete healing is usually obtained without much trouble, and the segment of the canal thus repaired remains supple and of adequate calibre.

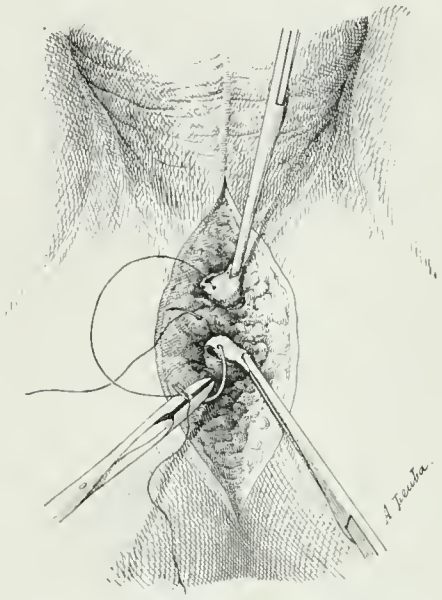

Fig. 39.—Attachment of the two ends of the ruptured urethra to the edges of the perineal wound (Guyon-Legueu). The two ends are exposed and secured by forceps; a preliminary suture is passed through the upper wall of each and, when tightened, will draw them together.

We have had occasion to treat two cases of traumatic rupture of the urethra by this method, and the ultimate results were excellent. There is, however, sometimes a difficulty in satisfactorily suturing the two ends of the torn urethra to the skin at the primary operation; the important point is to bring the two orifices as close as possible, without traction, to the surface of the skin in the middle line.

Fig. 40.—Attachment of the ruptured urethra to the perineal wound. The two ends are fixed to the skin.

The posterior end cannot be found.—Thus far we have presumed that the posterior end of the urethra has been found and a catheter passed along it into the bladder; but there is another possibility which demands consideration—**what should be done if, after a careful search, the posterior end cannot be discovered?**

The difficulty may be met in two ways: (1) **Leave matters as they are,** fill the perineal wound with gauze, and wait, emptying the bladder if necessary by hypogastric puncture; possibly at a subsequent examination the orifice may be found; possibly also the urine may escape freely by the large perineal opening which has been made. (2) **By suprapubic cystotomy and retrograde catheterization.**

When the general state of the patient and the surrounding conditions permit, the latter plan is useful, as by means of it an immediate attempt may be made to restore the continuity of the canal more or less completely. The operation may, however, in some cases be attended with a good deal of difficulty (*Fig.* 42).

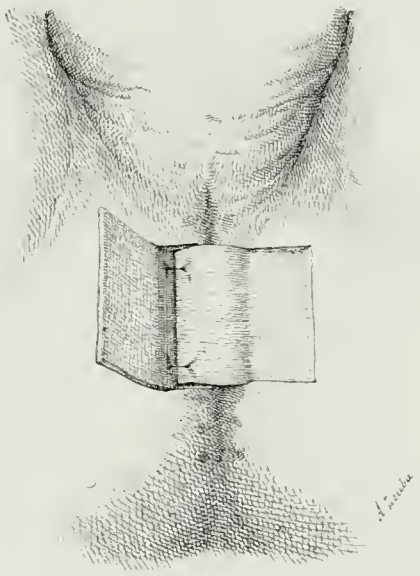

Fig. 41.—Plastic operation for closure of perineal fistula. The left flap is turned over the fistula, epithelial surface upwards; the right flap is cut and is about to be placed over the under surface of the first.

The hypogastric region is shaved and prepared in the usual manner. Make a median suprapubic incision 3 or 4 inches in length; the vesical distention which is usually present in these cases greatly facilitates the earlier stages of the operation. Below the abdominal wall a mass of yellowish fat will be found; it must be displaced upwards *en masse*, and retained under a retractor; *the peritoneal reflection is not seen, but is displaced upwards along with the fat.*

If the bladder is distended, it will be possible to feel and see it; if it is empty, it will be certainly reached by following the posterior surface of the pubes downwards, and by means of two traction threads passed through the anterior surface it may be drawn up into the parietal wound.

Open it in the middle line with the scalpel for a length of about 2 inches; the intravesical manipulations are unnecessarily complicated and prolonged by obstinately persisting in attempts to carry them out through a small opening; there is not the slightest advantage in trying to do this, because the incision can subsequently be closed so far as may

be deemed necessary. A traction thread is passed through either lip of the vesical wound, and the next step is to pass the catheter down the urethra from the bladder.

It is usually possible to see the vesical orifice of the urethra with the aid of a large speculum and a good light, but with a fat patient, the symphysis high and prominent, the bladder deep, and also in the more common urgent conditions, **the finger** must be the guide. There is always a tendency to seek for the opening too far back; *the neck of the bladder is situated in front, almost under the symphysis*, or at least in the prolongation of the axis of the symphysis downwards.

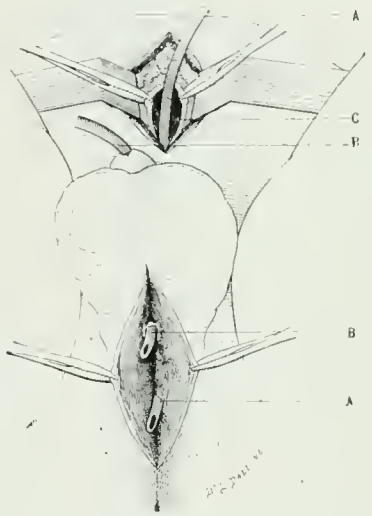

Fig. 42.—Complete rupture of the perineal urethra. Retrograde catheterization. (AA) Catheter introduced through the bladder into the posterior end of the urethra, and appearing in the perineum. (BB) Catheter introduced by the meatus into anterior end of the urethra. (C) Suprapubic opening in bladder.

Introduce the left index and middle fingers into the bladder, and carry them at once down to the base, in the direction of the pelvic floor; then draw them from behind forwards in the middle line; you will recognize the neck of the bladder in the form of a small elevation, surrounded behind and laterally by a more or less prominent semicircular ridge (the middle lobe of the prostate) with a central depression; if the patient is elderly, the prostatic prominence is well marked and constitutes an excellent landmark; sometimes no prominence can be found, but only an area of thickening, an indurated semicircular zone which under the tip of the finger feels like the margin of a small cup. Place the tip of the index finger on the point found, and along it conduct a catheter into the orifice; the instrument must have some degree of rigidity: an elastic gum catheter or, better still, a metallic one.

When the instrument appears in the perineum (*Fig.* 42) it only then remains to use it as a conductor to lead a soft rubber catheter into the bladder.

Cut off the tip of the soft catheter which had previously been passed down the anterior urethra into the perineum, and fit the open end over the tip of the vesical catheter; withdraw the latter carefully by the hypogastric wound, and it will draw the soft catheter after it, along the posterior urethra into the bladder.

When the rubber catheter appears in the hypogastric wound, detach it from the guiding instrument, and pass a stout double silk thread through the end, which is then allowed to fall back into the bladder, while the threads are fixed securely to the skin on either side of the wound to obviate any

risk of the tube slipping out of the vesical cavity, and so sacrificing all the advantages which had been obtained by a decidedly troublesome operation.

Or again, Tillaux's excellent plan may be adopted: instead of a soft rubber catheter, take a long piece of rubber tubing of the same bore; pass it along the anterior urethra to the perineum from the meatus; then, using the vesical catheter as a guide as before, draw the tubing along the posterior urethra into the bladder and out through the hypogastric wound, and draw out a sufficient length to allow the end to be placed in a receiver; some holes must be cut in the segment of the tube which is to remain within the bladder; lastly, place the portion of the tube which projects from the urethral meatus in the receiver into which the hypogastric end had already been led; in this way free drainage of the bladder is assured without any danger of the tube slipping out; after a few days a self-retaining rubber catheter may be substituted for the long tube.

The bladder wound, which has been made fairly large for facility of access, will be partially closed, and a few sutures will also be placed at the extremities of the suprapubic wound. The treatment of the perineal lesions will of course depend on their nature, and will follow the lines already laid down.

It must be clearly understood that all attempts at immediate repair of the damaged urethra and surrounding tissues are only applicable to comparatively recent and uncomplicated cases.

Too often we find that the infiltration is already very extensive, or that a huge urinary abscess is present; in such conditions, **a simple incision, laying the tissue planes freely open right down to the urethra,** is the only rational treatment. By means of it, the immediately threatening symptoms will be overcome, and at a later date the local conditions will be dealt with in the best manner possible, though the difficulties associated with these secondary operations are often very great because the primary lesions are always seriously aggravated by initial delay.

II.—RUPTURES OF THE DEEP URETHRA, WITH FRACTURES.

The prognosis is always much more serious when **a rupture of the deep urethra is associated with a fractured pelvis.**

The extravasation spreading in the intrapelvic planes of cellular tissue speedily produces very considerable disturbances; it is difficult to obtain direct access to the urethral lesion; besides, in the region where it must be attempted, catheterization of the posterior end is extremely difficult, and if the urethra should be compressed or torn by a fragment of bone, it is practically impossible under the circumstances to attempt to relieve the conditions by any direct measures. The essential point is to provide free escape for the urine at once, and so prevent the danger of extensive infiltration.

If there is **a definite swelling in the posterior part of the**

perineum, incise it in the middle line, or better, make a T-shaped incision, with the horizontal limb of the T crossing in front of the anus, and after cleansing the underlying cavity, *look for the posterior end of the urethra.*

If it is found, the further steps of the operation will be conducted on the lines already laid down ; usually, however, one must be content with placing a catheter in the bladder, while the perineal wound, however large it may be, must be simply packed with gauze and left widely open.

If the posterior end cannot be found, or if the urethra is compressed by fragments of bone, the operator must not confine himself to simply leaving the perineum open ; that would be a most uncertain plan, because nothing is known of the position of the bony fragments or of the character of the urethral lesions, and there are good reasons for supposing that the channel is not, and cannot become open, since it is closed by a bony obstruction which cannot be removed.

Suprapubic cystotomy should therefore be performed at once ; if the accident is quite recent, and the local disturbances are not yet extensive, retrograde catheterization may be attempted, but usually it is best simply to place a drainage tube in the bladder through the suprapubic wound.

When an examination of the perineum furnishes no definite localizing signs, suprapubic cystotomy and drainage is the plan which should always be adopted as first choice, leaving a prerectal drainage incision to be made at once if any swelling, indicative of commencing urinary infiltration, should appear. At a later date, when the primary dangers are past, the restoration of the permeability of the canal, always a difficult matter, will be undertaken.

III.—RUPTURES OF THE PENILE URETHRA.

I now come to **the ruptures of the penile urethra.** The following case will give a good idea of the evolution of these injuries, their dangers, and the urgent indications to which they give origin.

Case 8.—A powerful coalheaver, 29 years of age, was admitted to the Necker Hospital on the 8th of March, 1893, with extensive infiltration of the scrotum, the hypogastric region, and the penis, the last being black and gangrenous-looking in its anterior two-thirds. His story was as follows : On the preceding Sunday, the 5th of March, while tipsy, he had twisted his penis violently during coitus : he had felt intense pain, and noticed at once that blood was flowing profusely—in a jet—from the meatus ; he estimated the total quantity lost at about three pints. However, during the night he was able to pass urine naturally ; on the Monday spontaneous micturition was still possible, though not without pain. On Tuesday urine could only be expelled in driblets and with great straining ; finally micturition became altogether impossible, while the penis and scrotum became more and more swollen. In that condition he was brought to the Necker hospital, having passed not a drop of urine for forty-eight hours.

During the night a student made two incisions on the sides of the penis, and tried, without success, to pass a catheter ; nor was he more successful in

an attempt to empty the bladder by hypogastric puncture, the needle, undoubtedly, not penetrating deeply enough into the œdematous tissues.

On the morning of the 9th, the state of the patient was most critical ; the penis was insensitive, black, tense, and enormously swollen, and appeared to be gangrenous in almost its whole extent ; the infiltration affected the entire perineo-scrotal area, and extended very high in the hypogastric region ; the pain was intense, the tongue dry, the face earthy coloured, and the toxæmia deep.

After making large and multiple incisions in the infiltrated tissues with the thermo-cautery, I performed suprapubic cystotomy. I had to penetrate to a very considerable depth through the swollen tissues before I could feel the bladder ; I secured the organ with two fixation threads, opened it, and fixed the edges of the incision to the skin by a few sutures.

The operation was followed by immediate improvement ; the infiltration ceased to advance. The scrotum, the perineum, and the penis gradually resumed normal form and size ; the gangrene affected the cutaneous coverings of the penis only, and after a series of plastic operations which it would take too long to recount here, the patient left hospital at the end of four months, able to pass urine perfectly well, and with a penis which had been " repaired " in a very satisfactory manner. I saw him two years later ; he was then perfectly well, and quite satisfied, he told me, with the functional value of the organs he had so nearly lost.

We have here therefore a first clinical type of rupture of the penile urethra, **the rupture dating from several days previously and complicated by extensive infiltration.**

In such a case the method of treatment we have just detailed is in our opinion the best ; any attempt to reach the bladder or urethra through the swollen and œdematous perineal tissues behind the rupture would be attended by great difficulties, and the result would be very uncertain.

Go at once to the hypogastrium, open the bladder above the pubes, provide syphon drainage, and relieve the infiltrated tissues by free incisions made with the thermocautery. This is the best method of cutting short the threatening local and general conditions, and of arresting the progress of the gangrene of the penis.[1]

In recent cases the situation is not quite the same, and the correct treatment is more open to discussion. *If micturition is possible,* it may be sufficient to frequently irrigate the urethra with boiled water and to make a long incision on the under surface of the penis should any swelling develop.

When the patient cannot pass urine, or only with difficulty, a gentle attempt should be made to pass a catheter into the bladder ; but if any serious difficulty is experienced, a drainage opening must be provided at once behind the seat of rupture. There is a choice of two methods : **external urethrotomy,** opening the canal in the perineum behind the ruptured segment, or **suprapubic cystotomy.**

Personally we prefer *suprapubic cystotomy* : it is a simple operation which, with the aid of syphonage, insures very satisfactory drainage of the bladder, and is not attended with any risk of leaving a persistent fistula

[1] Complete gangrene of the penis due to extravasation of urine is very uncommon : but cases are from time to time observed. I have seen a very striking example in a man, 60 years of age, whose penis had sloughed almost completely, and was represented merely by two small nodules situated below the pubes.

after the natural course of the urine has been restored. With regard to this point in particular, perineal urethrotomy appears to us to be decidedly inferior, and daily experience shows, notwithstanding anything that may be said to the contrary, that fistulæ are not uncommon and are often very intractable. I may also point out that the opening of the urethra behind the point of rupture without a guide in the canal is not always a simple matter. For these reasons hypogastric drainage appears to us to be indicated.

With regard to direct incisions at the point of rupture, with suture of the two ends, the operation may be very troublesome and associated with profuse bleeding; and perhaps, even as a reparative measure, it is less efficacious than putting the ruptured urethral segment at rest by complete diversion of the stream of urine through a hypogastric opening, followed by instrumental dilatation of the canal as soon as healing is sufficiently advanced [1]

FOREIGN BODIES AND CALCULI IN THE URETHRA.

Here, as in other cases where foreign bodies are impacted in mucus-lined canals, **extraction by the natural passages** is the method of choice when it can be carried out without causing serious injuries to the wall of the urethra, and the latter condition depends on *the nature of the foreign body* and *the date at which the attempt is made*. There is therefore the greatest advantage in undertaking the extraction at the earliest possible time; indeed, in some cases the symptoms are so urgent as to demand immediate intervention.

Practically these foreign bodies may be divided into three groups: (I) *Fragments of catheters, bougies, or other instruments* accidentally broken off and left behind in the bladder or the urethra by a medical man or by the patient himself. (II) *Foreign bodies introduced by the patient*, of infinite variety, but possessing certain general characters in common. (III) *Calculi*, escaped from the bladder and arrested at some point in the urethra, or which have originated in a urethral diverticulum or in the prostate.

When the accident has happened under the hands of the surgeon, the situation is very definite, very worrying, and immediate extraction is demanded, not only because of the need for removal of the obstruction, but also for personal reasons. If, under these unpleasant circumstances, there is one recommendation more useful than another, it is to keep cool; such a misadventure has occurred in the hands of the best surgeons. Nothing must be attempted hurriedly, and in case of

[1] Incision at the site of rupture is, however, sometimes necessary in the presence of a considerable hæmorrhagic effusion, endangering the vitality of the organ.

necessity, if the appropriate instruments are not at hand, attempts at removal must be deferred for a few hours. **When the responsibility of the accident lies with the patient** himself, naturally the knowledge of the exact nature of the accident will be less definite ; it may be necessary to sift the truth from the more or less involved story ; in any case, however, instrumental exploration of the urethra, which is always essential, will clear up any doubts.

In certain cases the symptoms are too threatening to permit of any delay : retention of urine, persistent or repeated hæmorrhages, intense pain, aggravated by the slightest movement, swelling of the penis and perineum, indicate local infection and imminent danger of urinary infiltration. Even when micturition, though impeded, is still possible, and the condition causes less alarm, the single fact, duly verified, of the presence of a foreign body, constitutes an amply sufficient reason for immediate action. No reliance can be placed on the exceedingly doubtful chances of *late spontaneous expulsion*, and delay can only be justified as a temporary measure to give time to procure the necessary equipment.

The line of treatment is therefore always quite clear ; (1) **Try first to remove the foreign body by the natural passages,** adapting the methods employed to the characters of the object ; (2) **If extraction proves to be impossible, incise the urethra,** that is, perform external urethrotomy, over the foreign body.

1.

Let us first presume that we have to do with a relatively simple case : What is to be done if, during the passage of a catheter, a portion of the instrument has broken off and remained behind in the urethra ? The accident has just happened.

Some very simple measures may be at once tried, without, however, expecting any very striking results : Amussat's plan for instance. The end of a metal catheter had broken off in a stricture ; he caused the patient to attempt to pass water while he compressed the meatus between his fingers ; when the patient's efforts appeared to be sufficient and the urethra was well distended, he suddenly relaxed the compression, and the stream of urine brought out the foreign body with it. This plan is only likely to be efficacious in exceptional cases, but at any rate it is perfectly harmless. If the end of the catheter can be plainly felt through the urethra, an attempt may be made to work it along the canal from behind forwards ; but certain precautions are necessary to obviate any risk of pushing the foreign body more deeply into the urethra or into the bladder.

The first step therefore is *to fix the object* by pressure with the thumb or fingers on the perineum or penis immediately behind the spot at which it is situated ; while this guard remains in position, the fingers of the other hand will seek to push the foreign body along the urethra until it can be reached by means of ordinary forceps introduced at the meatus. If situate very deep in the membranous urethra, it will be useful to place a finger

in the rectum, and by pressure from above downward along the anterior rectal wall do what is possible to displace the foreign body downwards, or at least to prevent it from slipping into the bladder during the attempts at extraction.

The latter precaution, indeed, should never be omitted, even in the course of the preliminary examinations; smooth, rounded or cylindrical bodies have a decided tendency to slip more deeply along the urethra, and displacement into the bladder in a large proportion of the cases is a complication to be carefully avoided.

If these methods are not speedily attended with success, do not persist, but proceed at once to more direct measures.

If the end of the catheter is *not too far from the meatus*, or has been brought within reach by external pressure, one may sometimes succeed in seizing it and drawing it out with fine dissecting forceps, Kocher's, or bullet forceps; sometimes, when appropriate instruments are not available, a stylet slightly bent at the extremity may be made to penetrate into the interior of the retained fragment, or the end of a piece of wire, bent into a hook, may be passed beyond it and effect its removal.

The difficulties are much greater when the foreign body is situated in the *membranous or perineo-bulbar portions of the urethra*, and, if suitable instruments are not at hand, it is best to defer any attempts at extraction until they can be obtained. The following very simple plans may, however, be tried.

Take a catheter, open at the extreme end, of a size larger than that of the broken one; pass it gently down the urethra, and try *to ensheath the retained fragment* which is kept carefully fixed by external pressure; if this manœuvre is successful, extraction can usually be completed without much trouble; but the great difficulty always consists in insinuating the extracting tube around the broken end, the edges of which are often irregular and sharp; a finger in the rectum or on the perineum can be of considerable assistance. We shall again have occasion to mention this plan of *ensheathing* the foreign body when dealing with other types. Another plan which is worth trying is to take a catheter, of the same size as that which is broken in the urethra, cut off its tip, and pass it down the urethra into contact with the retained end; in this way the two segments form a continuous tube, along which a metal stylet may be introduced, enabling the two portions to be withdrawn together.

Or again, a fine bougie, curved or twisted like a corkscrew at the extremity, may be insinuated into the lumen of the retained fragment, and hooked into the eye, or perhaps, by inclining the shaft of the bougie strongly to one or other side of the canal, it may be possible to exercise a certain degree of traction, which, frequently repeated, may little by little succeed in withdrawing the foreign body.

Finally, there remains **instrumental extraction by the meatus**; with proper instruments it is the best method, and the one which should be first chosen.

There are many models of urethral forceps, hooks, and curettes; but any good urethral forceps, such as Collin's (*Figs.* 43, 45), with a urethral curette (*Fig.* 44) or a simple hook, will constitute all the instruments that are really useful for dealing with the contingency we are considering (the retention of a fragment of a catheter, bougie, or other urethral instrument), and with which quite as much can be done as with more complicated instruments.

The closed urethral forceps is slipped down the urethra until it comes in contact with the foreign body (which must be fixed by a finger from outside): the instrument is then opened, and, if dealing

Fig. 43.
Urethral forceps.

Fig. 44.
Urethral curette.

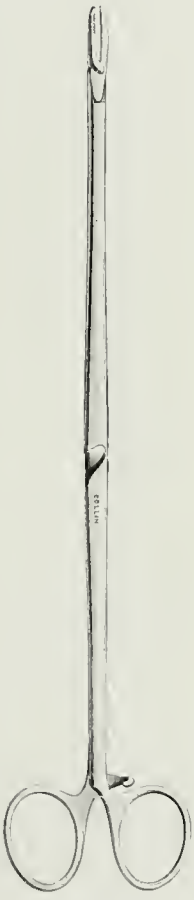

Fig. 45.
Urethral forceps.

with a piece of a catheter, efforts must be directed to seizing the fragment longitudinally: not transversely, which would give a very uncertain hold. The forceps is particularly useful for extracting small elastic catheters or fine bougies, which, even when seized transversely at some distance from the end, double up under the traction and are quite easily pulled out.

The curette may be employed to remove fragments of catheters of

larger size ; it is introduced closed into the lumen of the fragment, passed in as far as possible, then opened, and the blade hooked into the eye of the catheter.

The same object may be attained with a simple hook, but less easily ; and always with greater risk of tearing the urethral mucosa.

If the broken catheter or bougie is very deeply situated in the membranous or prostatic portions of the urethra, and attempts to displace it by external manipulations, or to extract it by instrumental means through the urethra, have failed, it becomes good practice—if indeed it has not already been done unintentionally during the attempts at extraction—to push it back into the bladder, and then to proceed at once to deal with it as a foreign body in the bladder, by extraction with a suitable instrument (*Fig.* 46).

It must be remembered, however, that displacement into the bladder is only to be considered as a method of necessity. Extraction by the natural passages is undoubtedly the result to be desired : but the operation must be carried out with gentleness and skill, not force ; unreasonable obstinacy, which prolongs the instrumental manœuvres unduly, is to be deprecated, and ultimately leads to operation being necessary on a contused, lacerated, and bleeding urethra, in the worst possible condition to resist

Fig. 46.—Guyon's hook for removing fine bougies from the bladder.

infection. Urethrotomy, when performed early, on a urethra free from any serious lesions, is a simple operation, and one which insures rapid healing because of the possibility of immediately closing the wound by suture. (See later, the technique of URETHROTOMY FOR FOREIGN BODIES.)

It may be that the extremity of the broken catheter or bougie has *from the first remained in the bladder* ; on withdrawing the instrument it is noticed that the end is wanting ; or perhaps a whip bougie screwed to the end of a more rigid shaft has been used, and the joint giving way, the flexible portion has been left behind. Here again, do not get excited, nor be in haste to do something ; there is no immediate danger ; the tolerance of the bladder for foreign bodies is well known. Therefore, if suitable instruments are not at hand, any attempts at extraction may be deferred without fear till the following day, for several days even, until the necessary instrument is obtained, that is to say, a small lithotrite with flat blades ; in the meantime keep your patient quiet in bed.

Such an accident happened to me at the Maison Dubois ; a rather old whip bougie broke at the joint and was left in the bladder ; the lithotrites at hand were too large to be of any use ; I ordered the patient to be given a hot bath and put back to bed, and next day, with suitable instruments, I experienced no difficulty in getting hold of and extracting the lost bougie.

It is not always safe, however, to expect the extraction to be easy, and when the operator is not accustomed to the use of the lithotrite, when there is prostatic hypertrophy, and the bladder is sacculated and perhaps contains calculi, it is exceedingly difficult to recognize when a proper hold has been obtained; it is not easy to distinguish whether it is the bladder wall or the catheter which is grasped in the jaws of the lithotrite. A very patient, methodical exploration of the bladder from behind forwards, to the right and the left, is essential; and once anything has been seized with the lithotrite one must make sure that the instrument is free, by drawing on it very gradually before attempting to remove it from the bladder; if there is any doubt, it is very probable that it is not the foreign body which has been got hold of.

Finally, do not persist unduly; a timely recognition and admission of failure is important, and then recourse must be had to suprapubic cystotomy, which after all is simpler and safer than prolonged and blind intravesical manipulations.

II.

A practical classification of other foreign bodies may be based on their *shape* and *superficial characters*, and accordingly as they are *mobile* or *fixed in the mucous membrane*.

(*A*). Some of them (pencils, rods of various kinds, etc.) have characters similar to those of the fragments of catheters and bougies which have just been considered; they are **cylindrical, smooth, of uniform diameter, and of variable length.**

For their extraction, the same external manipulations are applicable, the same attempts at ensheathing with a tube of larger calibre, or the use of forceps or hooks, and with them also, delay soon leads to local complications, in the presence of which, removal by open operation becomes the only feasible plan.

(*B*). Some other elongated, more or less cylindrical, foreign bodies, although without sharp points—and having therefore no tendency to bury themselves in the mucous membrane in the way pins do, for instance —**possess roughnesses or prolongations** which catch in the wall of the canal and prevent removal, even when the objects are within easy reach of the meatus; such for instance are quills, the knotty or branched stems of plants, sticks with rough surfaces, etc.

Direct traction could only succeed by causing multiple erosions or even considerable laceration of the mucosa; **ensheathing** is the method which gives the best results.[1]

[1] All sorts of special plans may be devised to suit particular cases, varying according to the nature of the foreign body, the instruments available, and the ingenuity of the operator. In a case mentioned by Voillemier, the patient had introduced a small branch—the thickness of a very large catheter—of a chestnut tree into his urethra; he had first peeled the stick; "but he had exercised so little care in doing so that the knife had cut into the wood and raised

This may be effected with a large catheter with the opening at the extremity of the tip, which dilates the urethra in front of the foreign body, frees the various irregularities, and being pushed gently onwards while a finger in the rectum or on the perineum fixes the foreign body, finally ensheathes the latter, which can then be easily withdrawn along with the catheter.

Or a small urethral speculum (*Fig.* 51) may be used. The speculum is passed into the urethra down to the foreign body, which can then be seized with a suitable instrument and fixed while the speculum is insinuated around it.

With the same object, M. Dayot has recommended the use of *a lead tube*, which can be readily improvised, thus:—A sheet of lead is taken and hammered out to the thickness of paper; it is then rolled around a catheter or bougie, converting it into a tube with a perfectly smooth surface; the outer surface of the tube and the bougie are lubricated with vaseline; then the bougie, which serves as a stylet, is introduced into the lead sheath and the apparatus passed gently down the urethra until it comes in contact with the object to be extracted.

"The leaden cylinder is now slipped down along the guiding bougie until some resistance is felt. While the foreign body is kept fixed by external pressure, the tube is pushed on by a sort of screwing movement or by rotation around its long axis; when it is supposed that the foreign body is completely ensheathed by the leaden tube, *the malleable walls of the latter are pressed together* by the fingers through the perineal tissues, so imprisoning the foreign body, which can then be withdrawn along the tube." By means of this ingenious contrivance M. Dayot has succeeded in three different cases in extracting a wooden rod, the end of a catheter, and the quill of a peacock's feather.[1]

(*C*). When dealing with a foreign body of **spheroidal shape**, instrumental extraction is practically the only method to be considered, and the urethral forceps (*Fig.* 45), if well handled, is the best instrument to use. I say well handled: that is to say, slipped down until it touches the foreign body, opened gently, and closed only when the jaws have been insinuated as far as possible around the middle of the offending body. If a proper hold is not obtained, the forceps will slip, and the only result will be to drive the object a little deeper along the canal.

In other cases, when the foreign body is irregular, partially embedded in the cul-de-sac of the bulb or in a diverticulum, or fixed by some irregularity of surface, it is a good plan to try to pass an instrument behind it, so as to be able *to displace it from behind forwards*: for this purpose, Leroy

little splinters which caught like barbs in the walls of the urethra when he tried to remove the branch." Voillemier cut the branch at about half an inch from the meatus, split the end in various places, and passed a blunt stylet along the whole length of the intra-urethral portion in such a manner as to divide it into a bundle of small longitudinal fragments. He then, with forceps, pulled out the central fragments, and the others one by one. The removal took three-quarters of an hour. (*Traité pratique des maladies des voies urinaires*, p. 531.)

[1] René Dayot, *Nouveau procédé d'extraction des corps étrangers du canal de l'urètre*. Thesè de doctorat, 1893.

d'Etiolles' curette or one of its numerous modifications may be used with advantage ; we have already referred to Collin's urethral curette (*Fig.* 44).

Urethroscopy is most useful in these conditions, if the necessary apparatus can be obtained, not only for the purpose of confirming the diagnosis, but also in facilitating extraction of the foreign body.

(*D*). I now come to the *sharp-pointed* bodies so often met with, usually pins of one kind or another, ordinary pins terminating in a rounded head, hairpins, and sometimes even needles.

Ordinary pins or hairpins are usually introduced head first or loop first ; their points are therefore directed towards the meatus, and become embedded in the mucous membrane, and all attempts at extraction by external manipulations or with forceps, without the guidance of vision, simply tend to bury them more deeply.

Special forceps, such as Reliquet's (*Fig.* 47), have been devised for

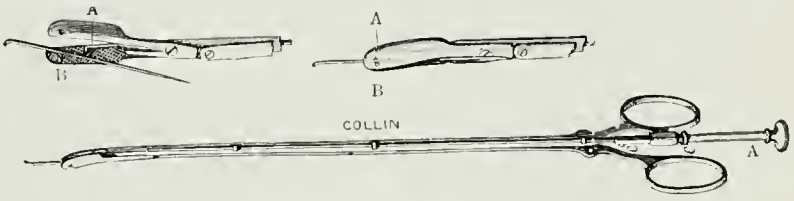

Fig. 47.—Reliquet's forceps for extracting pins from the urethra.

the purpose of disengaging, altering the direction of, and extracting pins, and are undoubtedly useful, but they are very seldom at hand when wanted.

Here again, **ensheathing** is often applicable, combined with certain plans directed to disengaging the points of the pins. In a case reported by Broussin,[1] the point of the pin was fixed in the glans about an inch behind the meatus, the lips of which were therefore seized with two pairs of forceps and pulled strongly forwards ; the point freed itself, and while an assistant kept the urethra on the stretch, a catheter with the tip cut off was introduced and insinuated around the point of the pin ; the penis was then retracted, and the catheter emerged from the meatus, and with it the point of the pin, which was seized and easily withdrawn. The same procedure is applicable to hairpins, the two ends of which one must try to enclose in the open end of the catheter.

It is always advisable to attempt direct extraction by one or other

[1] Broussin, of Versailles. *Corps étranger de l'urètre (épingle à chapeau) chez l'homme.* Rapport par P. Bazy. *Bull. de la Soc. de chir.*, 15 mars, 1898, p. 276.

of these methods before having recourse to Boinet's plan of "version;" this is extremely ingenious, but causes a good deal of bleeding and more or less injury to the urethral wall. It may be used for needles, ordinary pins, or hairpins.

Removal of *needles* is a very simple matter; it is an extraction through the urethral wall rather than a version. The needle is fixed posteriorly by the fingers, then the penis is bent upwards at the position where the point of the needle is embedded; by this movement the point is buried more and more deeply in the lower wall of the urethra, traverses the skin, and appears on the surface; all that is then necessary is to take hold of it and draw it out.

Fig. 48.—Removal of a pin from the interior of the urethra by the method of "version." 1st step.—The point of the pin is pushed through the inferior wall of the urethra.

In removing a *pin*, the first step is identical, but the head prevents complete extraction through the wall of the urethra; it is therefore turned round till it lies in front, so completing the "version."

A pin, as we have already said, is usually introduced head first into the urethra; the point is therefore directed towards the meatus and penetrates into the mucosa. By pushing on the head of the pin and bending the penis upwards, the point is made to perforate the lower wall of the urethra and to appear on the surface of the skin; it is then drawn outwards till the head is arrested by coming in contact with the inner surface of the canal (*Fig.* 48); by inclining the external portion of the pin backwards towards the anus (*Fig.* 49), the head is directed forwards, and may be easily pushed towards the meatus (*Fig.* 50), whence it can be extracted without any difficulty. The puncture in the urethra bleeds a little, but causes no trouble.

A *hairpin* with the points directed towards the meatus is removed in an exactly similar manner. The two points are made to perforate the lower wall of the urethra, and are drawn out till further progress is prevented by the loop coming in contact with the inner wall of the canal; then, by turning the points backwards, the median loop is tilted forwards and brought into the vicinity of the meatus by pushing on the two projecting limbs. The loop can then be seized with forceps or a hook (*Fig.* 51), and the pin extracted.

Once the two limbs have been drawn as far as they will come through the lower wall of the urethra, if the pin is very easily bent, one of them may be cut close to the skin and, by pulling the other, the

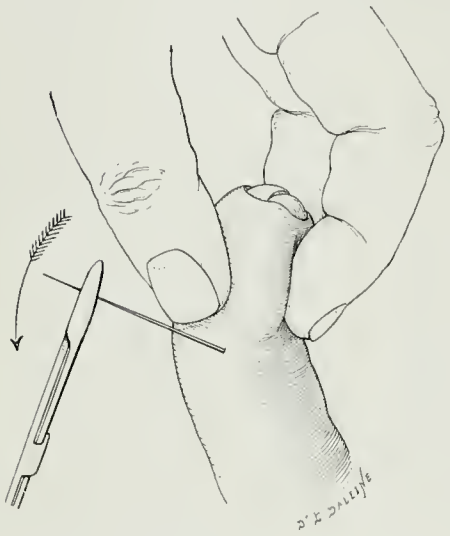

Fig. 49.—Removal of a pin. 2nd step.—The pin is rotated from before backwards, so turning its head towards the meatus.

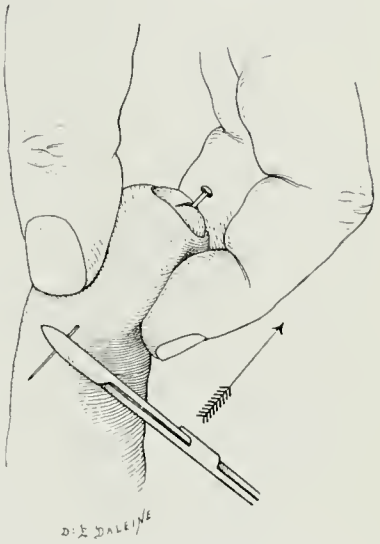

Fig. 50.—Removal of a pin. 3rd step.—The pin is pushed, head first, towards the meatus.

loop may be straightened out and the pin extracted through the urethra.

Here again we must add that all these methods of direct extraction and the many possible modifications are scarcely applicable to any but

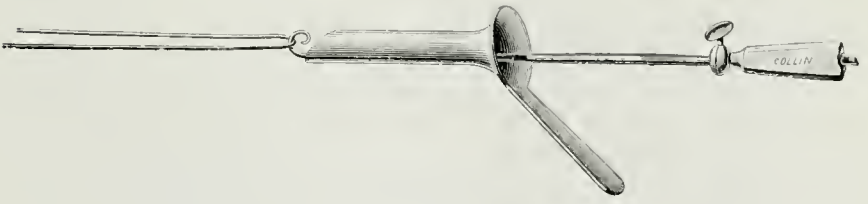

Fig. 51.—Hook, with urethral speculum, for extracting hairpins, etc.

recent cases; when the foreign body is encrusted with lime salts, or when secondary lesions of the wall of the canal are present, removal by urethrotomy is the simplest and least harmful measure.

III.

External Urethrotomy is also required when the urethra is occluded by a **stone,**[1] which can *neither be pushed back into the bladder, there to be subsequently crushed*, nor *extracted* with suitable instruments, nor *broken up* in the urethra. The following case will give a good idea of the urgent indications which may suddenly arise as a result of the impaction of a calculus in the urethra.[2]

Case 9.—A man, aged 60 years, was brought to us in a very alarming condition, having passed hardly any urine for four days. He was very fat, gouty, and a great drinker; he had been affected for several years with constant polyuria; two years before, he had suffered with retention of urine, which had lasted for two days, and had terminated spontaneously by the expulsion of a stone from the urethra. For five days there had been attacks of vesical tenesmus, which had become very frequent and painful, and the quantity of urine passed had steadily diminished. Finally, on the day I saw him, a few drops of urine only were from time to time expelled with great straining, associated with extremely severe pains which radiated to the groins and the kidney regions. The bladder, though distended, was not very large, his face was drawn and yellow, the tongue dry, and the pulse rapid; the temperature was not raised.

On exploring the urethra with an olivary bougie (No. 8 English) the instrument was completely arrested in the membranous area by a hard, immobile object, which appeared to completely plug the canal; even filiform bougies could not be got past the obstruction. On deep palpation over the perineum a sort of indefinitely rounded, stony-hard, and well-defined nodule could be felt at the point where the bougies were arrested. The nodule did not feel at all like an indurated stricture, and besides, the past history we have already related, the similar attack two years previously, and the rapid development of the existing symptoms, all appeared to indicate clearly the nature of the obstruction, while the peculiar sensation given by a metal bougie on contact with the object definitely confirmed the diagnosis of a **Calculus impacted in the Urethra.** I have said that the stone was quite immovable, that even the smallest bougies could not get past it, and that it appeared to completely fill the lumen of the canal. Therefore, after a very short attempt to remove it with urethral forceps, external urethrotomy was performed.

The prominence of the calculus served as a guide; a median perineal

[1] These intra-urethral calculi are not uncommon: Zeissl, in 1883, collected 154 cases; Kaufmann, in 1886, added 44 more; Heimann, in 1898 (*Einige Fälle von Steinen in der Uretra*. Thèse de Strasbourg, 1898), found 37 cases in men and 11 in women, all occurring after 1886. As V. Lieblein has so well pointed out, it is necessary to distinguish between vesical calculi arrested during passage through the urethra, and those calculi which originate in the urethra, or which have at least been situated in the urethra for a considerable time, and have there sometimes acquired a considerable size: the congenital and pathological diverticula of the urethral mucosa and the various urethral cul-de-sacs are frequently occupied by these concretions. (Victor Lieblein, Zur Kasuistik der Harnröhrensteine und speciell der Divertikelsteine der Harnröhre. *Beiträge zur klinischen Chirurgie*, 1896, Bd. XVII, I, p. 141.) The acute symptoms which give rise to the urgent indications seem to be caused especially by migrating vesical calculi or by accidental displacement of a true endo-urethral concretion.

[2] Obstruction of the urethra by a calculus may be followed by very extensive and rapidly developing urinary infiltration: in a case occurring in a child two and a half years old, reported by Heimann (*loc. cit.*) the calculus, the size of a cherry-stone, was impacted in the membranous urethra, and the infiltration extended from the knees to the chest. In one of Lannelongue's cases the patient was a child two years of age: the calculus had been impacted for forty-eight hours, and had caused urinary infiltration of the scrotum and penis; the stone was extracted with Leroy d'Etiolles' curette; it was the size of a large pea. ("Calcul de l'urètre chez un enfant de deux ans. Infiltration urineuse." *Bull. de la Soc. de chir.*, 22 juin, 1880, p. 488.)

incision was made, and the urethra opened without much difficulty in front of the obstacle, the opening being prolonged backwards till the concretion was exposed; as soon as it was removed, a jet of urine escaped and the bladder rapidly emptied itself. The incision in the urethra was closed, and the perineal wound sutured in layers and a catheter left in the bladder.

In cases of this kind, where **the calculus is fixed and completely occludes the urethra,** primary urethral incision is evidently the only suitable line of treatment.

It is only when dealing with bodies of smaller size, or elongated shape, which leave some space between them and the wall of the urethra, that *extraction* with suitable forceps or curettes, or *crushing*, if the necessary instruments are available, can be considered.

Removal by the natural passages is not, however, a simple undertaking in unpractised hands, and the wall of the canal may very easily be seriously injured by ill-directed efforts. It is certainly very much better to decide at once on extraction by open incision.

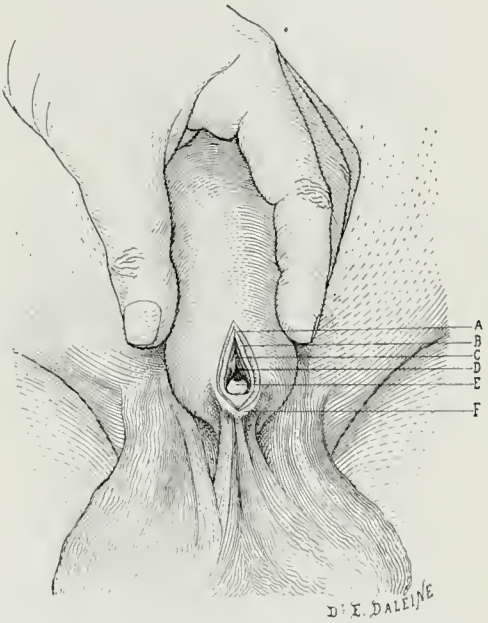

Fig. 52.—Small incision in the penile urethra for the extraction of a pencil.[1] (A) Subcutaneous tissue. (B) Fibrous layer. (C) Muscular layer (bulbo-cavernosus.) (D) Urethral wall. (E) End of the pencil. (F) Prominence caused by the pencil in the bulbar region.

We can now summarize the **indications for external urethrotomy for foreign bodies in the urethra.**

It ought to be practised whenever *serious but gentle attempts at extraction by the natural passages have failed*; it is indicated as a primary measure when a foreign body of some size is *embedded in the urethral wall*, or *encrusted and rendered immobile by a thick deposit of lime salts*, or *occupies the deepest portion of the urethra*, or is *partly in the bladder and partly in the urethra*.

The nature of the operation varies according to the position of the impacted foreign body.

If it is situated **in the anterior segment of the urethra, not far from the external orifice,** an incision of the lower angle of the meatus in a downward and backward direction will give sufficient access to allow

[1] It was an ordinary pencil, impacted in the membranous urethra and quite immovable; its anterior end projected prominently under the urethral wall at the level of the bulb. I made a small incision over the prominence, and removed the foreign body without trouble; suture of the wound. Recovery.

of its extraction, and the incision will then be at once sutured. Farther back **in the penile urethra** the incision is made in the following manner: the offending body is made to project on the under surface of the penis by curving the latter strongly upwards, and the corpus spongiosum is incised directly over the prominence (*Fig.* 52); sometimes a very small opening at one of the extremities of the foreign body will be sufficient to allow of it being seized and extracted, but if there is the slightest difficulty, there should be no hesitation in enlarging the incision, otherwise the urethra will be chafed and all the advantages of extraction by open operation will be lost. The hæmorrhage is always profuse, but need cause no alarm; it will be quickly checked by the suturing (*Fig.* 53).

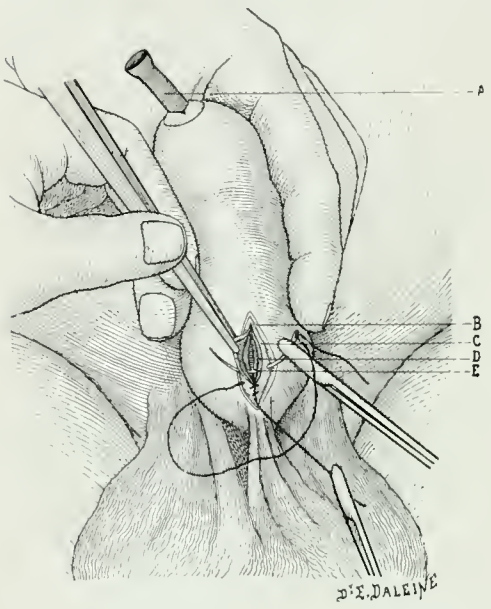

Fig. 53.—Incision in the penile urethra; suturing the opening after extraction of the foreign body. (A) Catheter. (B) Subcutaneous tissue. (C) Fibrous layer. (D) Muscular layer. (E) Needle picking up the muscular and fibrous layers without traversing the mucous membrane.

Farther back still, **in the perineum or in the membranous portion of the urethra,** the classical external urethrotomy must be performed, but without a staff in the urethra. The foreign body itself will often take the place of a guide. If it is so deeply situated that its anterior extremity cannot be felt from the exterior, a metal catheter or bougie should be passed as far as possible down the urethra, and will serve to indicate the position for the perineal incision. The tissues will be divided layer by layer down to the catheter; as soon as the urethra is opened, the two edges of the incision will be secured with forceps or traction threads, and the foreign body extracted. The question then arises as to whether the urethral wound should be closed or not. In comparatively recent cases, when the wall is not greatly altered, friable, and infiltrated, suture is always indicated; if properly done, by means of a continuous suture or a series of interrupted sutures, carefully placed, not passing through the mucous membrane (*Fig.* 54), and supported by suturing the musculo-aponeurotic perineal tissues (*Fig.* 55), it will ensure rapid healing and give an excellent result.[1]

[1] One cannot give a better illustration than the case reported by Terrier in 1886, and which appears to be the first in which this practice was adopted: the patient was a man, 62 years old, who had introduced a leather lace, about five inches long, into his urethra. On

In the opposite conditions it will be wiser to leave a part of the urethral incision open, or at least, after having sutured the urethra, not to close the superficial planes. The indications are here, indeed, based on the reasons which we have already mentioned when discussing ruptures of the urethra.

A few words only are necessary with regard to **foreign bodies in the female urethra or bladder.** The shortness of the female urethra and the ease with which it can be dilated, greatly facilitate extraction by the natural passages. Digital dilatation, if carefully performed, is always the best method, and it has the additional advantages of being available anywhere, and of permitting the most adequate exploration.

Begin by introducing the tip of the carefully cleansed and well-lubricated little finger into the meatus, and by keeping up gentle, steady pressure with a slight rotary

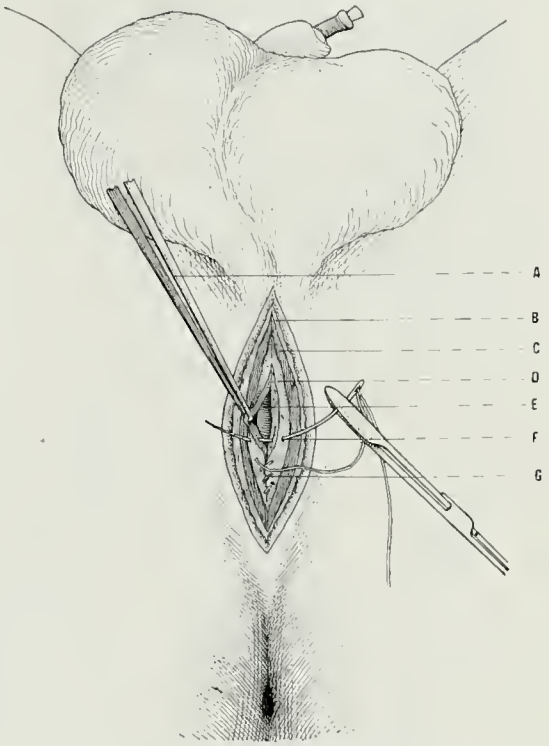

Fig. 54.—Suturing the wound after external urethrotomy. Suturing the urethra. (A) Forceps holding one of the edges of the incision in the urethra. (B) Superficial perineal fascia. (C) Bulbo-cavernosus muscle. (D) Urethra. (E) Catheter in the urethra. (F) Needle traversing the urethral wall. (G) Continuous suture uniting the edges of the urethral incision.

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passing a catheter an obstruction was detected five and a half inches from the meatus, just below the symphysis pubis: a hard, non-fluctuant, and only slightly tender swelling could be felt from outside on the right side of the urethra, with its long axis parallel to the canal. There was no interference with micturition. M. Terrier made a three-inch incision in the perineal raphe. "After section of the skin and the subcutaneous cellular tissue, a grooved staff was introduced into the urethra down to the obstacle, and served as a guide to the incision in the deeper tissues. The urethra was opened for a length of about three inches. Its wall appeared normal and the mucosa healthy, but on the right side the orifice of a small cavity was seen; the cavity was filled by a blackish substance which proved to be the leather lace, coiled on itself and much softened, for it broke during extraction, which was, however, effected without difficulty. Although bulging into the canal and thus preventing the passage of instruments, the foreign body had formed a cavity for itself in the corpus cavernosum, which constituted the hard swelling already mentioned, lying to the right of the urethra."

A large soft rubber catheter was then passed down the urethra into the badder, and the urethral wound was closed with nine interrupted sutures of fine catgut, care being taken not to perforate the mucous membrane. The wound in the superficial tissues was left widely open. On the 10th day there was a small separation, about one-third of an inch long, of the urethral wound, but it closed speedily. (*Bull. de la Soc. de chir.*, 27 oct. 1886, p. 762.) The lace had been placed in the urethra several weeks before the date of operation. The conditions are evidently less suitable for immediate suture in late operations than in the cases where immediate urethrotomy is necessitated by complete or almost complete obstruction.

movement, the resistance will speedily be overcome. If the patient is anæsthetized, with a little time and patience one can without much trouble introduce the index finger into the bladder, as we shall again have occasion to mention.

I presume that the foreign body has remained in the urethra, sometimes, though comparatively seldom, free; or become implanted in the mucous membrane, or embedded in a depression in the lower wall; it can be felt and its characters recognized with the little finger; sometimes it may be displaced into the axis of the canal, or even hooked with the finger tip and extracted; the finger will at least form a guide along which to slip suitable forceps or a hook down to the foreign body, in order to seize and extract it.

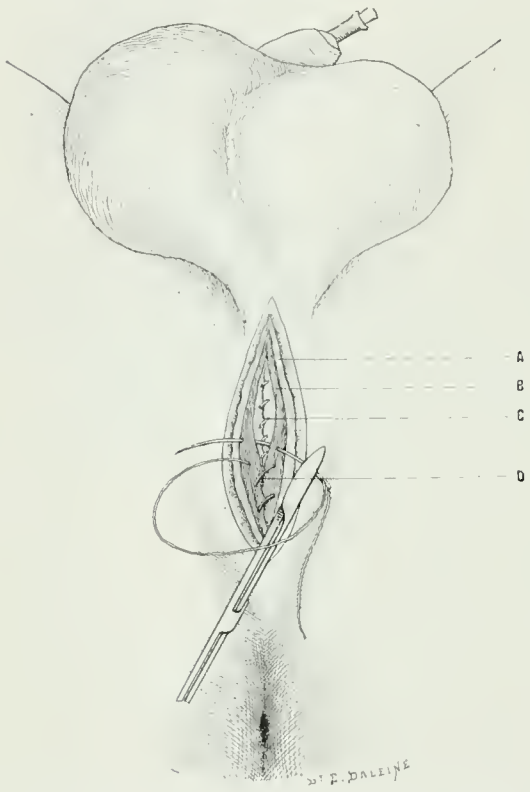

Fig. 55.—Suturing the wound after external urethrotomy. Suturing the deep perineal planes. (A) Superficial perineal fascia. (B) Muscular layer. (C) Sutured wall of the urethra. (D) Continuous suture uniting the edges of the incision in the muscular layer.

Sometimes, however, where the true nature of the condition has not been recognized, and the foreign body has been allowed to remain long enough in the urethra to become encrusted with a thick deposit of lime salts, and has perhaps given rise to very grave symptoms, extraction becomes a more difficult matter. I removed, in the way which I shall now describe, the hairpin depicted in *Fig.* 56 from the urethra of a girl, 17 years of age, who was sent to me after having been treated for several months for supposed tuberculous cystitis. The diagnosis was not unreasonable in view of the symptoms: frequent and painful micturition, pyuria, hæmaturia. A catheter passed into the bladder without any great difficulty, but it grated over a hard body lying on the lower wall of the urethra; on dilating the meatus I saw the black loop of the pin, but it was quite immobile. I incised the lower wall of the urethra back to the foreign body, which I then succeeded in dislodging. It was embedded in a sort of pouch formed at the expense of the wall of the urethra. The two edges of the

incision were united by several interrupted sutures of catgut, and healing took place without any trouble. Of course, all signs of "tuberculosis" soon disappeared. The patient confessed that the pin had been introduced six months previously.

Fig. 56.—Hairpin, coated with a deposit of lime salts, having lain in the urethra for six months (natural size).

Foreign bodies do not often remain long in the urethra, but usually **slip into the bladder.** In such circumstances the need for immediate extraction very seldom arises, and it is generally advisable to delay until suitable instruments can be procured; still, even in default of any special equipment, a foreign body may sometimes be very simply removed, after digital dilatation of the urethra, by a finger in the bladder aided by another in the vagina.

Therefore dilate the urethra slowly under general anæsthesia, first with the little finger, then with the index, and proceed to explore the interior of the bladder, at the same time depressing the hypogastrium with the disengaged hand. It will now be possible to detect the foreign body and recognize its shape, length, and direction, and not uncommonly to bring it down to the neck of the bladder; two fingers of the left hand, introduced into the vagina and working through the base of the bladder, will be of great assistance in the intravesical manœuvres. Once the foreign body has been placed in a proper direction at the neck of the bladder, it may sometimes be expelled spontaneously, or may engage in the urethra, where it may be seized with forceps and extracted.

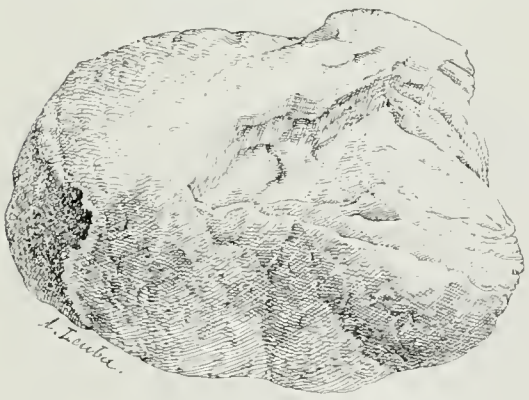

Fig. 57.—Large urethro-vesical calculus.

At other times, after having found and fixed the foreign body by means of the intra-urethral finger, one of the instruments already figured may be passed into the bladder along the finger, and after having made sure that a good hold has been obtained, the finger may be withdrawn and the extraction completed.

It is only when the retained body is very large and coated with a deposit of lime salts, or very long and incarcerated in the basal pouch, or embedded in the wall or at the apex of the

bladder, that it becomes necessary to open a larger way of approach by a urethral or vagino-vesical incision.

Although very uncommon, the large vesical calculi embedded in the neck of the bladder or in the deep urethra require mention. The calculus represented in *Fig.* 57 was removed from the bladder of a woman 62 years of age ; an enormous, hard, and fixed foreign body could be felt occupying the lower part and neck of the bladder and the commencement of the urethra ; the pain was extremely severe, the urine was tinged with blood, and dribbled away continuously, and the entire urethro-vulvar region was infiltrated and inflamed. I was compelled to incise the urethro-vaginal and the vesico-vaginal wall for a length of about 2 inches before I succeeded in extracting the stone, which could not be broken up, by slipping a finger behind it and tilting it over from behind forwards.[1]

URGENT CATHETERIZATION, HYPOGASTRIC PUNCTURE, AND CYSTOTOMY.

The above heading indicates the triple series of measures which may be necessitated by **acute retention of urine.**

We cannot here discuss all the details of catheterization, and shall therefore only consider those cases in which the need for emptying the bladder is imperative and **it is difficult or practically impossible to pass a catheter.**

These emergencies often permit of no delay; a practitioner should therefore always possess a suitable equipment for dealing with them. The necessary instruments are comprised in the following list :—

Metal Catheters (two or three) of different curves, each in a single piece ; " pocket-case catheters " in two pieces ought to be absolutely proscribed, and a sterilizable metal box should always be substituted for the ordinary case.

Nélaton's Catheters of Soft Red Rubber (*Fig.* 58) ; Nos. 6 to 14 are the most useful, the larger and smaller sizes being only rarely required.

Elastic Catheters, olivary (*Fig.* 59), Nos. 3 to 10 ; coudé catheters, particularly those with wide angles (*Fig.* 61), and open-ended catheters (*Fig.* 60) ; the last may, however, be improvised from ordinary catheters by cutting off the ends with a sharp scalpel or a razor (not with scissors), and then smoothing the cut edge.

Elastic Olivary Bougies (*Fig.* 62), Nos. 3 to 10 ; **filiform bougies,** which may be moulded to various curves as required (*Fig.* 63) ; some whip bougies will also be useful. A **urethral syringe,** or at least *a urethral cannula* which can be fitted to the tube of the irrigator.

The adequate sterilization of these instruments is a matter of the utmost practical importance. As a general rule, in urgent conditions, boiling is

[1] *Soc. de chir.*, 11 déc. 1906, p. 1079.

practically the only available method, and is perfectly satisfactory, but it must be continued for at least ten minutes in water to which some carbonate or sulphate of soda has been added. Nélaton's soft rubber catheters stand boiling perfectly well, but the elastic bougies and catheters

Fig. 58.—Nélaton's soft rubber catheter.

Fig. 59.—Olivary elastic catheter.

Fig. 60.—Open-ended catheter.

do not, and for them it is advisable to have one of the various forms of apparatus in which the sterilization is effected by means of formaldehyde fumes.

The conditions under which the need for immediate catheterization arises vary considerably with the cause of the retention.

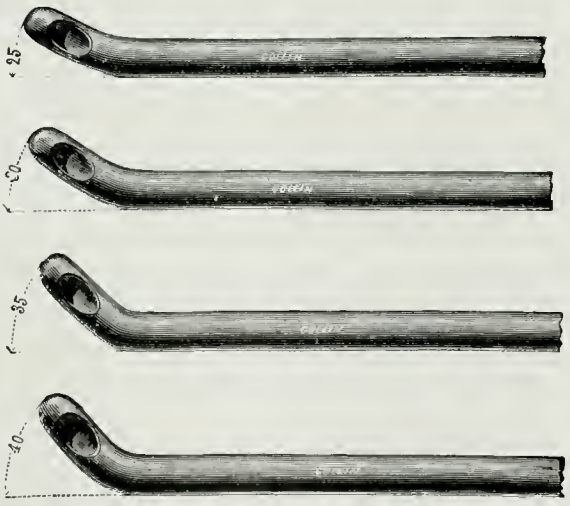

Fig. 61.—Coudé catheters of various angles.

I.—Even when **the retention is apparently purely functional**, when it occurs, for instance, during the course of a febrile malady or after an injury not implicating the genito-urinary organs, and when there is no history or indication of any abnormality of the canal, and although the

introduction of a catheter into the bladder would appear to be a very simple matter, it will always be well to be doubtful and to keep in mind the possible existence of some *latent lesion or spasmodic contraction.*

How often has an obstruction been discovered in the urethra when there had been good reason for thinking it perfectly permeable ; the patient had noticed no difficulty in micturition, and declared that he had been able to pass urine perfectly well prior to the unexpected retention which has just developed ; but a close interrogation elicits a history of long-past gonorrhœa and of certain long-standing urinary disturbances which, though mild, and having passed almost unrecognized, are none the less definite.

This careful cross-examination ought always to precede the use of the instruments, and if the patient's condition is such that no definite information can be obtained, it is always necessary to make the necessary provision for dealing with possible difficulties.

Fig. 62.—Elastic olivary bougie.

Fig. 63.—Bayonet-shaped filiform bougies.

As a general rule *a large soft rubber catheter should be first tried* when it is necessary to catheterize a urethra the condition of which is unknown ; if the canal is normal, the large instrument will pass without much difficulty in spite of any spasmodic contraction which may be present. This fact has been long established : a small catheter provokes a much greater resistance, and finds its way with greater difficulty in a spasmodically contracted urethra than an instrument of larger calibre.

If the large catheter fails to reach the bladder, the attempt will be repeated with a smaller size, if again this fails, recourse must be had to one or other of the following procedures.

One rule, applicable to all catheterization and all other intra-urethral explorations, must first be laid down : wash the glans penis and the meatus with soap and water, wash out the urethra with boiled water by means of a suitable syringe or irrigation apparatus (of course properly sterilized), wash the hands, and take care that the catheter does not come in contact with the prepuce, the scrotum, or the fingers which hold the penis, before being entered into the urethra.

These are very simple precautions, but are far from being constantly observed ; indeed one may say that in urgent practice nothing is more

uncommon than aseptic catheterization. Another important preliminary: have the patient placed in a good position, lying on the back with his head raised, a pillow under the hips, the thighs flexed and moderately separated.

Lastly, the catheter will be lubricated with olive oil, liquid vaseline, or ordinary vaseline; the lubricant must be sterilized.[1]

II.—The treatment becomes more difficult in the case of **acute retention in a patient with an enlarged prostate or a stricture,** and it is still more essential that it should be conducted carefully and methodically.

We still see, only too often, badly damaged urethras, on which persistent and unskilful attempts have sometimes been prolonged for hours; urethras lacerated, bleeding, and beset with false passages—the patients themselves exhausted, infected, and doomed to all the dangers of urinary fever. For beginners, for those who have not daily experience in the use of urethral instruments, nothing is more worrying than prolonged resistance of the urethra, which soon tempts one to try to overcome it by force.

But **force must never be exercised in trying to pass a catheter or bougie; proceed gently, methodically, and patiently, and know when to stop:** these are the fundamental principles which ought always to be observed.

Here is a man, some sixty years of age, known to be affected with prostatic enlargement, who, after some dietetic indiscretion on the previous evening, had been suddenly attacked with acute retention of urine. The practitioner is called to see him next morning; he finds him looking pale and ill owing to pain and loss of sleep; the distended bladder shows itself prominently in the hypogastrium; *it must be emptied as soon and as simply as possible.* It will be fortunate indeed if the retention has not existed for an even longer time, if repeated and forcible attempts at catheterization have not been made, and if the patient is not already suffering from septic absorption. After the preliminary preparations mentioned above, begin by trying to pass a soft rubber catheter (No. 9 or 10); push it in slowly, with a screwing movement; sometimes, against all expectation, you will succeed, because congestion plays the chief rôle in causing these retentions, associated probably with a certain amount of spasmodic contraction. If the catheter[2] enters the bladder, there will follow the satisfaction of knowing that the object has been attained with the minimum of instrumentation.

Should the soft catheter fail, then *try a metal one of the same calibre and with a very large curve*, and carefully observe the successive steps in the process of introduction; in other words, the penis being drawn up

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[1] In a water bath, maintained at boiling point for half an hour at least. Carbolic oil should not be used as a lubricant for urethral instruments, as it irritates the mucous membrane. Professor Guyon recommends the following: Soap powder, glycerin, water, of each 33 parts, β-napthol 1 part.

[2] In prostatic cases it will sometimes be necessary to introduce almost the entire length of the instrument before it enters the cavity of the bladder.

over the abdomen, enter the tip of the catheter at the meatus, the concavity of the instrument being turned towards the thigh,[1] and slip it down to the perineum; then carry the shaft to the middle line and, before depressing it, push the tip gently as far forwards as possible, at the same time drawing the penis a little upwards; *then slowly depress the shaft between the thighs*, while keeping the tip pressing forwards into the urethra. The second step is the important and also the dangerous one. If the instrument sticks and the shaft cannot be depressed, do not persist; one may be sure one has not got the proper direction, and the employment of force will only damage the urethra.[2]

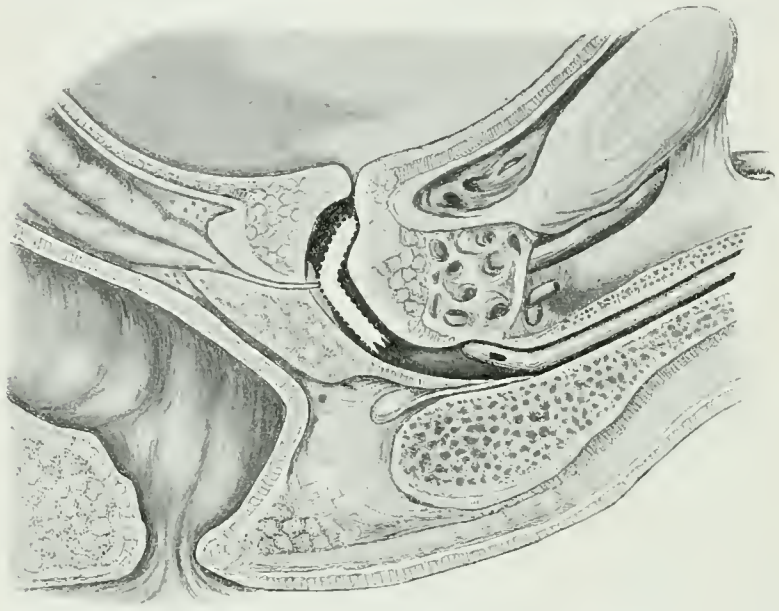


Fig. 64.—Passing a coude catheter, in a case of hypertrophy affecting the middle lobe of the prostate; the tip of the instrument follows the upper wall of the canal (Forgue).

Let us suppose that the metal instrument also has failed to reach the bladder. As a rule, however, some idea will have been gained as to the nature of the obstruction and the degree of curvature of the deep urethra.

Take a coudé catheter (*Fig.* 61), introduce it like a metal catheter, and when the tip has reached the membranous urethra, while depressing the shaft try to insinuate the tip through the prostatic channel. *Figs.* 64 and 65 give a good idea of the necessary manœuvre.

[1] When using a metal catheter on a patient with a fat abdomen, it is always well to hold the instrument primarily in the direction of the fold of the groin, and not to bring the shaft into the middle line until the commencement of the second step.

[2] Metal catheters, if badly handled, may be very dangerous instruments: they should therefore be used as little as possible; further, all those special manœuvres, "tour de maître," Abernethy's method, etc., should be avoided.

When all these have failed, then the series of *elastic gum catheters* must be tried. Various curves may be imparted to the instrument with the finger before introduction into the urethra ; possibly, in the end, a fine catheter, well softened in hot water, will find its way through the tortuous canal into the bladder. This will give only a very small flow of urine, and complete evacuation of the bladder will take some time ; it does not matter, however ; the difficulty has been overcome in the simplest possible way ; the catheter will be fixed in the bladder, and a long rubber tube adapted to it to form a syphon, following the practice which we shall presently describe ; the patient will be relieved, and there will be no further immediate anxiety.

If the retention is of a few hours' duration only, and if the conditions of place, distance, etc. (points always deserving careful consideration in

Fig. 65. — Diagram illustrating the changes in the shape of the floor of the prostatic urethra produced by hypertrophy of the middle lobe (after Thompson).

urgent surgery) permit, one may, after the failure of the first attempts at catheterization, defer any further direct measures for a time, and try the effect of a prolonged hot bath, an excellent method in the milder cases.

When the situation is urgent, and it is necessary at any cost and immediately to empty the bladder, do not persist obstinately with efforts to pass an instrument along the urethra, after a reasonable number of careful, methodical attempts, conducted in the manner we have just described. Undue insistence is to be deprecated, particularly when the urethral mucosa is in the friable and congested condition so common in patients with old-standing prostatic enlargement, and also when the urethra has already been damaged during previous attempts.

It is not necessary to empty the bladder by way of the urethra : **make a suprapubic puncture** (*Fig.* 68). This is a simple measure, and certainly much less harmful[1] than many attempts at catheterization ; and remember that the evacuation, *by putting the organ at rest*, always exercises a beneficial influence on the urethro-prostatic congestion ; after one, two, or perhaps three punctures, and a prolonged hot bath, the retention will not uncommonly yield spontaneously, or one may succeed, without much

[1] With the reservations which we mention on p. 86, note.

trouble, in catheterizing a urethra which had before seemed absolutely impassable.

The catheter ought then to be left in the bladder, and due provision be made to insure its efficient action, and that it causes no discomfort. Naturally, when difficulty has been experienced, *it is the catheter which has been introduced which will be left in the bladder*; if there is a choice, the preference will be given, following Professor Guyon's advice, to an elastic coudé catheter "of large internal calibre and with two large eyes;" the largest possible instrument has the additional advantage of adapting itself as completely as possible to the wall of the canal. Lastly, care must

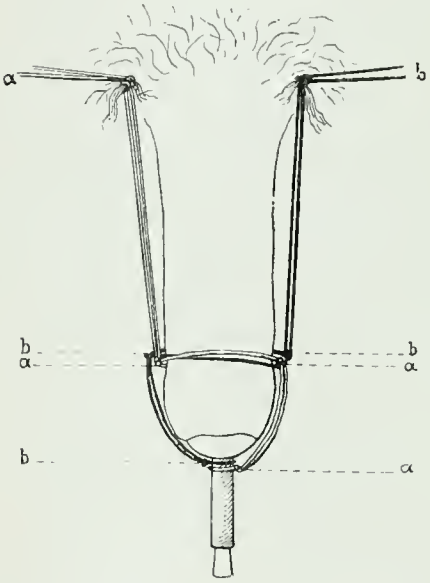


Fig. 66.[1]—Fixation of a catheter in the bladder, with two loops of thread (*a a a a—b b b b*).

Fig. 67.[1] Catheter fixed in the bladder; the penis dressed with a triangular compress.

be taken to so place the catheter that the urine escapes drop by drop, and to fix the instrument securely in the proper position.

When the intravesical orifice of a catheter is in good position, quite close to the neck of the bladder, the urine escapes in a regular succession of drops. Make sure, by pressure on the hypogastrium, that the bladder is completely empty; withdraw the catheter a little until urine ceases to escape, then push it back slowly till the flow reappears; in this way, after a few trials, the exact position of the catheter at which the urine escapes "drop by drop" can be determined.

[1] These figures are taken from M. Henri Langlois' thesis, *La sonde vésicale à demeure, technique, indications, résultats thérapeutiques*, 1900.

Now proceed to tie the catheter into the bladder. *Fig.* 66 renders a description of the method of doing this almost unnecessary. Take two threads, each about 2 feet in length, and double them. The middle loop of one thread is knotted around the catheter close to the meatus ; the two ends are carried along the side of the glans ; at the level of the corona they are knotted together and carried, one in front, the other behind, to the opposite side of the penis, where they are again knotted together and then conducted together to the root of the penis and tied to a tuft of pubic hair. The second thread is applied in a similar manner ; the loop is fixed around the catheter, the ends carried along the opposite side of the glans to the level of the corona, knotted together, interlocked with the first thread, carried around the penis, again knotted and interlocked with the first thread, and then led direct to the pubic hair.

Lastly, it is a good plan to dress the penis with a sterile compress, folded into a triangle, the base of which is applied under the root of the organ, and the apex at the meatus ; the two basal angles are carried around the penis and secured as shown in *Fig.* 67 [1]

If it is necessary to provide for permanent drainage of the bladder, other measures, which we shall consider presently, are available.

The patience and method which ought to be exercised in catheterizing a patient suffering from prostatic enlargement are equally necessary in dealing with **acute retention due to stricture.**

In these cases it will save time and avoid unnecessary irritation of the urethra by unsuitable manœuvres, **if the canal is first explored with olivary bougies ;** such means will give some idea as to the tightness of the stricture or strictures, and enable an estimate to be formed of the possibility of introducing a medium or small-sized elastic-gum catheter, or the necessity for the preliminary use of filiform bougies.

In fact, except for those cases of stricture of large calibre in which the retention is in great part due to spasm, it is preferable to use elastic catheters, since they can most easily be insinuated through a narrowed channel ; if the smallest catheter will not pass, then try a filiform bougie.

The introduction of the latter instrument is a matter of skill and patience, and in some degree also, it must be admitted, of chance ; *but it is never a reason for the employment of force*, and that is why rigid instruments, whalebone bougies for instance, appear to us to be dangerous ; one thinks that the rigid instrument has passed through the stricture, and pushes it a little further, while, in reality, it has simply perforated the mucous membrane. Try the bougie in all ways, following the upper, then the lower wall of the urethra, by raising or depressing the penis, by inclining it to the right or to the left, by stretching it moderately or allowing it to hang flaccid. If the orifice of the stricture appears to be eccentric, bend the tip of the bougie like a bayonet (*Fig.* 63), twist it like a corkscrew, give it any shape which you think may be useful ; any improvised curve or shape may be

[1] Guyon et Michon, Contrib. a l'étude de la sonde à demeure. *Ann. des mal. des organes génito-urinaires*, 1895, t. XIII, p. 385.

made permanent—for the time being—by painting on a thin layer of collodion and allowing it to set.

If a fine bougie has been successfully passed, the bladder will not be evacuated forthwith; but gradually the organ will empty itself if the instrument is left in place: the urine will soon begin to escape drop by drop between the bougie and the wall of the canal, and in addition it will not be long before the drainage channel will be enlarged by the softening of the stricture where it lies in contact with the foreign body; often, by the next day it will be possible to substitute a small catheter for the bougie.

Therefore *leave the bougie in position:* it will not plug the urethral channel, but will gradually open it up; if there are no urgent symptoms, that will be all that is immediately necessary. Under contrary conditions, the bladder will be emptied by suprapubic puncture.

In the female, catheterization is usually a very simple matter; as a rule it is advisable, however, to use a soft catheter, and one must never adopt the ridiculous and out-of-date practice of passing the instrument "under the clothes," the least fault of which is that it prevents the essential preliminary cleansing of the vulva and meatus. At an advanced stage of pregnancy, and also by some tumours, the urethra is pushed forwards behind the pubes, and the catheter must be introduced from below, almost vertically upwards. It is difficult to tie an ordinary catheter into a female bladder; the best plan is to use Malécot's or De Pezzer's self-retaining catheter.

Suprapubic Puncture of the Bladder.—The equipment necessary for dealing with cases of acute retention of urine must include an aspirating apparatus or a long trocar of small calibre. Nothing is more simple than this puncture, practised on a distended bladder which pushes up the abdominal wall, and as it were, presents itself to the trocar, if the following indispensable precautions are observed: To shave the hypogastric region; to wash it first with soap and boiled water, then with alcohol; to flame-sterilize the trocar and cannula—the two being separated—or, better, to boil them.

The puncture is made immediately above the upper border of the symphysis, **exactly in the middle line** (*Fig.* 68) and the trocar must at once be thrust to a depth of 1½ or 2 in. Care must always be exercised to pass the trocar deeply: in some cases, where the abdominal walls are thick, fat, or œdematous, there is a risk of failing to reach the bladder through not going far enough. Besides, there is nothing to fear,[1] if the needle or trocar is introduced in the middle line at the point indicated.

[1] At least in the great majority of cases; it must not be forgotten, however, that when there is an old stricture—still more in old-standing prostatic cases with vesical infection, the peritoneal reflection may descend to an abnormally low level, and may even be fixed to the symphysis by adhesions due to pericystitis, and that it has several times been opened by the needle or trocar, and infected by the septic urine; these dangers have been emphasized by Carlier. If compelled to make the puncture under such conditions, care must be taken to introduce the needle immediately in contact with the pubes, and directed a little obliquely downwards behind it.

Then go in boldly till the urine begins to flow; generally the sensation *of being in a cavity* will be very definitely perceived as soon as the needle has penetrated the bladder wall.

The evacuation must be effected slowly, without "too much vacuum," if an aspirator is being used; directly the bladder is empty, the instrument is withdrawn by a sharp movement, and a sterile compress applied firmly over the area where the puncture has been made. The latter is an important precaution, particularly when one is compelled to use a trocar of rather large calibre, because it happens not uncommonly that the orifice in the

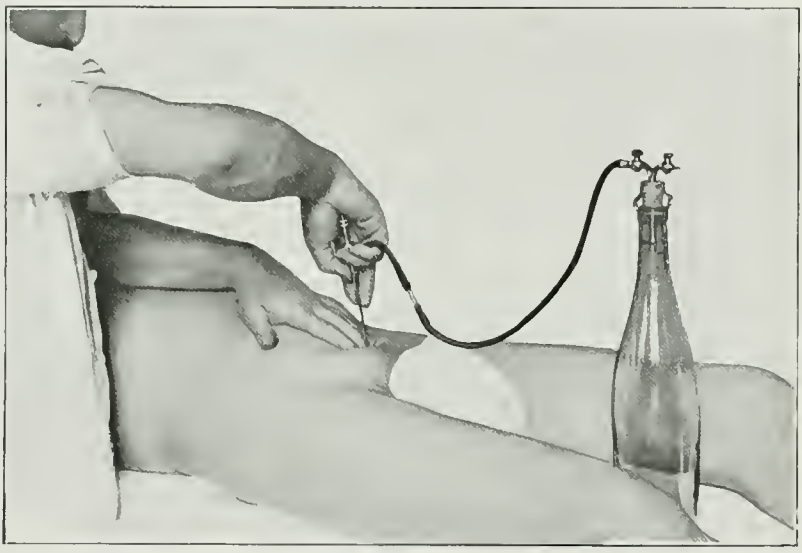


Fig. 68.—Suprapubic puncture of the bladder.

bladder, small though it be, allows a few drops of urine to escape. If a small instrument has been used, the cutaneous orifice closes at once, and may be covered with a little cotton-wool and collodion. If performed aseptically the puncture may be repeated a considerable number of times, and the bladder emptied by means of it two or three times daily. There is, however, a limit to such repetition, and after a certain time—which will vary according to the patient's tolerance, the condition of the suprapubic area, and the general reactions—if the urethral difficulty cannot be overcome, it will be necessary to provide for continuous drainage of the bladder.

CYSTOSTOMY AND CYSTO-DRAINAGE.

We have therefore a first indication for **continuous suprapubic drainage of the bladder**, in other words, for cystostomy. There are others.

(1). And first of all there is an *indication dependent on the situation and surroundings of the patient*, a relative indication certainly, but one that is nevertheless important and which frequently presents itself in country practice.

The practitioner has been called to a distance to see a patient who is suffering from acute retention of urine due to prostatic enlargement or stricture ; he is able to relieve the urgent symptoms by catheterization or puncture of the bladder, but the conditions are such that **it is quite impossible to give the patient adequate attention**, which would necessitate several visits daily. Is he to leave him without having taken steps to prevent the retention which must otherwise recur in a few hours?

(2). Another condition. *A patient is found suffering from serious toxæmia*, with shivers, fever, and earthy-coloured face ; the urethra, on which attempts have already been made to pass instruments, is beset with false passages, bleeding, œdematous, and extremely sensitive ; there is already some infiltration of the scrotum, in the perineum, and around the penis.

Under such circumstances it is urgently necessary to provide a free way of escape for the urine, to disinfect the bladder, and to ensure complete rest for the urethral canal for a longer or shorter period.

The indication is even more pressing when acute retention occurs in a patient who is already in a condition of *chronic infection*, for instance, in a prostatic patient whose urine has been purulent for a long time.

Therefore, **acute retention complicated by threatening toxæmia, the practical impossibility of repeatedly emptying the bladder by suprapubic puncture** and waiting till the urethra becomes permeable, **prolonged failure of attempts to catheterize the bladder** necessitating **excessive repetition of the suprapubic punctures**, are the reasons which in my opinion indicate the necessity for immediate suprapubic drainage.

I say "suprapubic drainage" ; as a matter of fact there are two methods of attaining this object : **puncture of the bladder with a large trocar**, followed by the introduction of a catheter which is left in the channel—and **cystostomy.** There is no choice between these two methods ; the one, cysto-drainage, is rendered necessary by certain conditions of environment or equipment ; the other, **cystostomy, is the operation which should always be performed when possible.** No doubt can therefore exist with regard to the application of the two procedures ; I need hardly say that I have no idea of placing them on the same plane. Undoubtedly cystostomy, the technique of which we are about to describe, is a simple, easy operation which every practitioner ought to be able to do well ; personally I have performed it in cottages, in the country, by the light of two candles, with a haphazard equipment, and my patients have recovered. That is true ; but still I must repeat, in certain conditions an isolated practitioner, without instruments and without assistance, will not—cannot—do the operation of choice, and it is for such

exceptional eventualities that cysto-drainage, which, if well done, will give good results, ought to be reserved.[1]

Suprapubic Cysto-drainage.—If compelled to have recourse to it, proceed in the following manner: Take a large curved trocar and a soft rubber catheter which passes easily into the cannula; the trocar is flame-sterilized or boiled, the catheter boiled, the hypogastric region shaved and washed, the operator's hands washed.

Puncture as before, in the middle line, immediately above the pubes; after withdrawing the trocar, push the cannula well in; it ought to penetrate far enough into the interior of the bladder to prevent it from slipping out as the organ empties itself; then allow the urine to escape. When the evacuation is completed, the rubber catheter is slipped into the bladder through the cannula, which is then gently withdrawn.

The catheter being now in the bladder, it is always advisable to connect it with a *syphon tube*.

A piece of rubber tubing long enough to reach the floor at the side of the bed will answer perfectly; the tubing will be attached to the end of the catheter, directly or by means of a piece of an elastic catheter or a piece

Fig. 69.—De Pezzer's self-retaining catheter.

of glass tubing, etc., which will serve as a connecting-piece on which the two segments to be put in continuity will be tied; the other extremity of the syphon tube will be immersed in a glass jar containing boiled water or sublimate solution. Once fitted, the syphon action will be started by one of the various well-known plans, and if the apparatus works properly the urine will flow drop by drop from the terminal orifice of the tube, and the bladder will be in a condition of *continuous drainage*.

Of course this apparatus lends itself to various modifications, according to circumstances and the material available; with two or three soft-rubber catheters, invaginated one into the other at the ends, or joined by improvised connections, an efficient syphon may be made to discharge into a receptacle placed on a chair or other suitable support near the bed.

It is important to fix the catheter securely in the bladder by means of several threads attached to the skin by collodion (if a self-retaining catheter (*Fig.* 69) is not available), and to watch that the syphon tube does not become displaced; for the latter consideration, a very long tube is always more convenient, because, if it is well secured at the hypogastric

[1] The installation of a syphon apparatus will prevent urinary infiltration of the prevesical space, which is the principal danger to be feared in Méry's operation, cysto-drainage of necessity.

region, it allows the patient to turn about in bed or to sit up without disturbing the drainage.

Cystostomy. I have already said that cystostomy must be considered as the operation of choice, and that it is a simple and easy one. A general anæsthetic is not necessary, and, particularly in urgent conditions, cocaine is quite sufficient; on one occasion I performed the operation without any anæsthetic whatever; the patient was an old man, 77 years of age, and desperately ill; he recovered, however, and I saw him again ten years later.

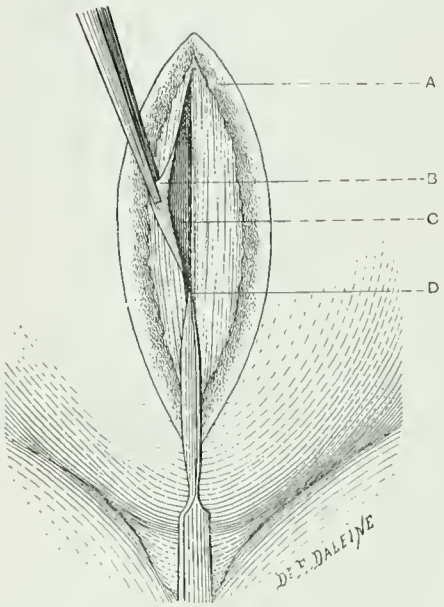


Fig. 70.—Suprapubic cystostomy. Lateral vertical incision through the sheath of the rectus. (A) Subcutaneous fat. (B) External edge of the incision in the sheath of the rectus muscle retracted outwards. (C) Rectus muscle. (D) Vertical incision, to the side of and parallel to the linea alba.

Very few instruments are required, and the following will suffice: a scalpel, scissors, some pressure-forceps, dissecting forceps, Reverdin's needle (or any ordinary curved suture needle of moderate size). The operation area is carefully shaved, submitted to the usual preparation, and surrounded with four aseptic compresses.

Make a median vertical incision about four inches in length, beginning or ending at the upper border of the symphysis pubis; do not hesitate to prolong the incision a little further upwards if the patient is obese and the prevesical planes are loaded with fat. As we shall see immediately, in urgent cystostomies performed on distended bladders, the peritoneum has been pushed very high up, and in any case, whatever its position may be, it is easily avoided by a very simple manœuvre.

Cut down boldly through the skin and fat to **the aponeurosis of the linea alba**, the first rallying point; divide the aponeurosis, and the second rallying point, **the deep layer of yellow fat**, comes into view; often it is better to make the incision somewhat to the side of the mid-line, and to traverse one of the recti muscles.[1]

Split the anterior wall of the sheath of the rectus (*Fig.* 70), separate the fibres of the muscle, and below it open the deep layer, and as before expose the underlying fat (*Fig.* 71); to avoid any risk of opening the peritoneum, the incision in the deep aponeurotic layer should commence quite close to the pubes, and should be continued upwards on the finger.

[1] With the idea of making a sort of sphincter around the suprapubic opening (Jaboulay).

One is now in the prevesical space, and the distended bladder can be felt quite plainly. Retract the fat, from very low down upwards (*Plate III*), in one unbroken mass with the left index and middle fingers; with it, the peritoneal cul-de-sac will at the same time be displaced if by chance it descends lower than usual, or if it is attached to the pubes by fine fibrous bands; the latter is a very exceptional occurrence[1] and need not cause uneasiness, as by the very simple manœuvre just described all risk of damaging the peritoneum is avoided.

After the fat has been displaced, the anterior surface of the bladder will be seen if the incision has been made long enough and its edges are well retracted; it appears as a rounded, bulging wall of a violet colour and marbled with large veins; in fat persons, and when the symphysis is very high and vertically placed, the bladder often seems to lie at a very considerable depth notwithstanding its distention; but if the operation has been carried out in the way described, there can be no uncertainty; the tense rounded swelling which can be felt and seen, more or less easily, behind the pubes, is *the bladder*, and can only be the bladder.

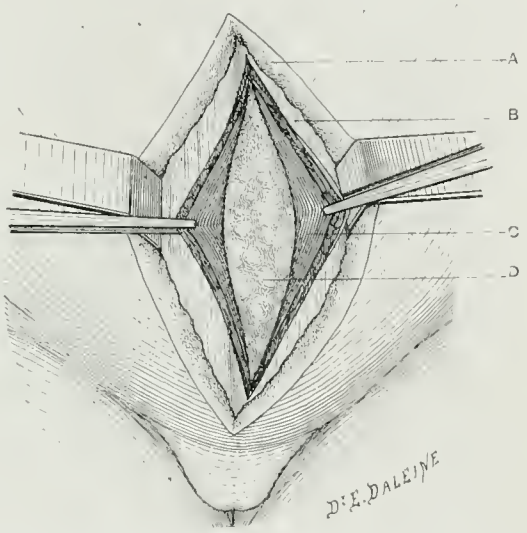


Fig. 71.—Suprapubic cystostomy. Incision through the rectus muscle; exposure of the prevesical fat. (A) Subcutaneous fat. (B) Anterior wall of the rectus sheath. (C) Rectus muscle incised longitudinally and retracted. (D) Prevesical fat.

Before opening it, pass two loops of thread, one on either side of the middle line, through the thickness of the wall (*Plate III*); these two threads will serve as landmarks and tractors, and will be very useful when the time comes for introducing the vesico-cutaneous sutures. They are not, however, indispensable; if the vesical wall seems to be too friable, or if the organ is too deeply placed, it may be punctured at once, and while the stream of urine is escaping, the edges of the wound can be seized with suitable forceps. Puncture the bladder in the middle line with the scalpel between the two large longitudinal veins which course over its anterior surface—if they are visible; make the puncture at the level of the upper border of the symphysis, and with the cutting edge of the knife directed upwards, enlarge it for a length of $\frac{1}{2}$ or $\frac{3}{4}$ inch.

[1] But it is necessary to be aware of this possibility, as adhesion of the peritoneal reflection to the symphysis pubis has several times been observed.

The bleeding is usually pretty free during this stage of the operation, and occasionally the wound is inundated with dark venous blood; do not trouble about this, nor lose time in trying to seize the bleeding vessels with forceps; open the bladder: *that is the best means of checking the hæmorrhage.* Directly the organ is empty, the venous bleeding will cease spontaneously owing to the retraction of the bladder wall.

Allow the dark, fœtid urine—often mixed with pus—to run away; then irrigate the field of operation and the bladder freely with boiled water.

Fig. 72.—Suprapubic cystostomy. The operation ended. (A) Suture in the upper part of the wound. (B) Superior commissural suture. (C) Lateral vesico-cutaneous sutures.

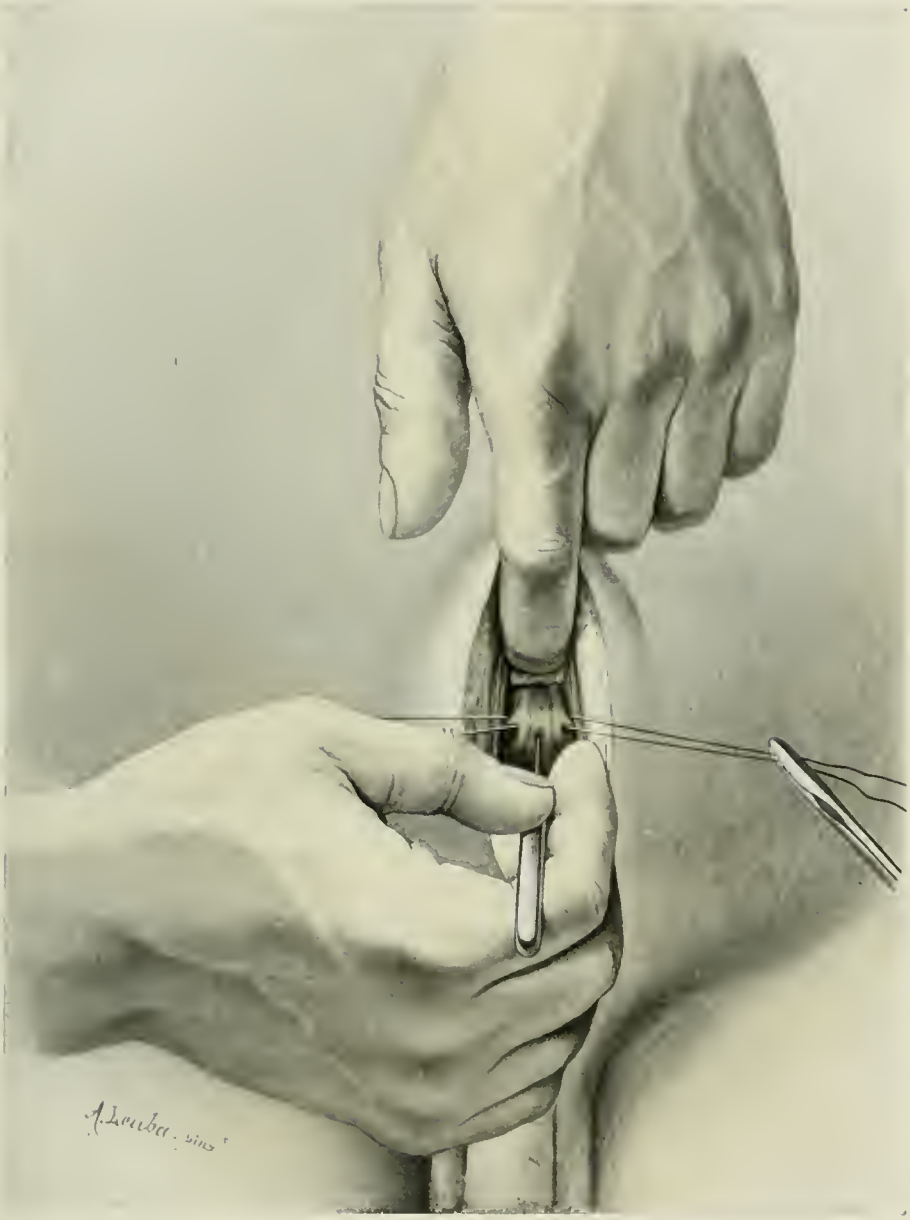
When this cleansing is completed, proceed to the vesico-cutaneous suture; before doing this, however, do not neglect to **explore the vesical cavity** with the finger. To omit this step would be to renounce one of the principal advantages of the open operation; very often it will be the means of making some valuable discoveries and of completing the operation most satisfactorily. On several occasions, in these bladders with enlarged prostates, I have, during the course of a cystostomy performed for acute retention of urine, found quite a mass of calculi.

One must always **endeavour to unite the edges of the vesical opening to the skin, at least partially.** As to the so-called ideal cystostomy—that is to say, the regular, circumferential suture of a cone of mucous membrane to the skin edges,—it is not always either possible or even necessary.

If the mucosa possesses sufficient strength and mobility to allow of it being drawn up into the wound, one may unite it alone to the skin by a circle of interrupted sutures of catgut or silkworm gut.

The following method is excellent and of more general application: two commissural sutures are first passed at the upper and lower angles of the vesical wound, including in their loops the whole thickness of the lips of the parietal wound and the musculo-fibrous coats of the bladder, with, or better without, the mucous membrane. By means of these two sutures, the bladder is firmly attached to the abdominal wall, and by two or three secondary sutures placed between them on either side the skin and mucous edges are adjusted (*Fig. 72*).

Plate III.—Suprapubic cystostomy. The index finger displaces the prevesical fat; the anterior wall of the bladder is raised by two loops of thread and incised in the middle line.



SUPRAPUBIC CYSTOSTOMY

These methods are sometimes impracticable owing to the friability of the bladder wall ; the best plan then is to fix the bladder to the margins of the external wound by a circle of four or five sutures passed through the whole thickness of its wall ; the edges cannot be adjusted very correctly by this method, but all these wounds usually arrange themselves remarkably, and often unexpectedly, well ; the capital points are to insure firm adhesion of the anterior wall of the bladder to the abdominal wall, the placing of the two incisions, vesical and cutaneous, opposite one another, and the patency of the drainage opening. If the suturing has been satisfactorily done, nothing should be placed in the opening ; this is often the best plan to follow here, as well as in other cases where the edges of an opening in a mucus-lined cavity are attached to the skin (artificial anus, cholecystostomy, etc.) ; in the contrary conditions, a catheter will be placed in the bladder and a syphon tube fitted to it in the manner already described. Finally, the edges of the upper part of the parietal wound will be brought together by one or two interrupted sutures, including the aponeurosis and the skin (*Fig.* 72).

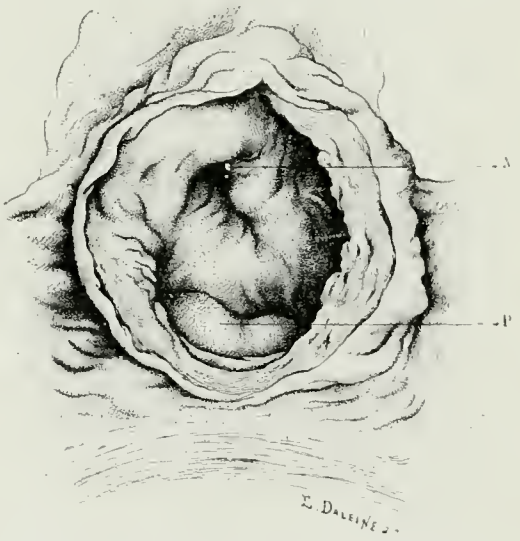


Fig. 73.—Bladder of a prostatic patient who had lived for 18 months after cystostomy. (Taken from our *Leçons de Chirurgie*, 1895). (A) Vesical orifice of the suprapubic fistula. (P) Prostate.

We cannot enter into the late results of cystostomy ;[1] but simply say that in the urgent cases we have in view it is often a very valuable operation, but must always be considered to be a temporary measure only. After some days, when the acute crisis has passed, fresh attempts must be made to pass a catheter along the urethra. Our aim must be to restore the permeability of the urethra sufficiently to allow of normal or at least tolerable micturition, and the suprapubic fistula is only a step towards that object. If the difficulties in the way of re-establishing the permeability of the canal are very great, if the bladder is badly infected and is seriously diseased, this "artificial urethra," which will insure free escape of the urine and allow of disinfection of the bladder, must be retained for perhaps a considerable time ; in some prostatic cases it may be necessary to retain it indefinitely (*Fig.* 73) ; but the patients themselves

[1] See Professor Poncet's book, *Traité de la cystostomie sus-pubienne*, 1899.

will in most cases demand to be freed from the discomforts associated with it, and the desirability of more radical measures, prostatectomy, etc., may then be discussed.

INJURIES OF THE PENIS AND SCROTUM.

I.—INJURIES OF THE PENIS.

We have already considered the ruptures of the penile urethra. It may happen that **a fracture of the penis** involves only the corpora cavernosa, and not the urethra; the nature of the lesion will be indicated by the absence of urethral hæmorrhage, the ease with which the patient micturates, and with which catheters can be introduced. In such a case often nothing will be needed primarily beyond keeping the patient and the injured organ at rest; if the effusion of blood is great and is progressively increasing, the indication may present itself for opening up the injured area, clearing out the effused blood, and suturing the lacerated corpora cavernosa; one must not forget, however, that any such operation is necessarily associated with a very considerable amount of bleeding, and if the symptoms are not too pressing, it will always be well to wait for at least thirty-six or forty-eight hours.

Wounds of the penis likewise bleed severely: a distinction must be made between those that affect only *the prepuce* or *the sheath of the organ* and *the deep wounds* which involve the erectile tissue.

If the cutaneous sheath alone is injured (cut or lacerated), treatment will be limited: (1) to checking the bleeding; the cut vessels retract very far and must be followed up and ligatured; in doing this, it may be necessary to enlarge the wound; and (2) to reuniting the divided tissues, at least partially; any excision of tissue, with the object of obtaining regular wound edges, is to be avoided.

When the erectile tissue is wounded, hæmorrhage is a very real danger, and hæmostasis is often difficult. Local compression will often be sufficient in the case of a superficial cut of the glans; it is a very different matter, however, with extensive sections of the corpora cavernosa (a razor cut for instance at the root of the penis). It will be well, first of all, to pass a catheter into the urethra and make sure of the integrity of the canal; then the cut surfaces of the wounded cavernous body will be brought together by a series of interrupted sutures, placed close together and penetrating deeply into the erectile tissue in a manner which will secure as exact and firm adjustment as possible; the cutaneous envelope will then be united by a few points of suture. This is the best means of obtaining hæmostasis.

If the urethra also is wounded, the first step will be to pass a catheter into the bladder and to fix it there; the two ends of the canal will then be sought for and united (*see* RUPTURES OF THE URETHRA); the operation, which is often a very troublesome one, will be completed by suturing the divided cavernous bodies. Circular compression of the penis close to the

pubes, by the fingers of an assistant or with a piece of rubber tubing, is a great help: by temporarily checking the bleeding it allows a clear view of the wounded area.

Gunshot wounds usually bleed but little, and primarily require only careful cleansing and the installation of a catheter in the bladder, without any attempt at immediate repair.

Certain lacerations are associated with a very rare lesion: **dislocation of the penis.** In these cases, the cutaneous sheath has been violently dragged forward, and has been detached at the level of the balano-preputial fold; the body of the penis slips back, right to the bottom of the long empty tube, and lodges under the skin of the scrotum, in the prepubic region or in the groin. If the urethra is not ruptured, micturition is still possible, the urine being discharged through the empty sheath. The dislocated organ must of course be reduced; in other words, the orifice of the cutaneous sheath must be dilated and retracted as far back as possible, while at the same time the dislocated penis is pushed in the opposite direction, and an effort made to get hold of the glans with forceps. If the attempt fails, the only thing to be done is to effect open reduction by means of an incision along the raphe, and afterwards to close the wound by careful suturing.

Lastly, we must mention **constriction of the penis with a cord or a metal ring, etc.** The indication is easily formulated: to divide the constricting agent at once. Cutting forceps or a fine saw—and very often the help of a locksmith—will be required in dealing with metallic substances. It may also happen that a very thick and hard ring will resist all attempts at division; in a case reported by Poncet[1] the patient, four days previously, had introduced his penis into the eye of a hammer-head, weighing a pound: gangrene was threatening. A locksmith declared that it was impossible to file through the metal. The patient was anæsthetized. M. Poncet then made several incisions going along the corpora cavernosa, and by systematic pressure emptied the œdematous cellular tissue, and after lubricating the penis well, finally succeeded in freeing the organ. Recovery ensued without any complication. This case will serve to indicate the line of treatment to be followed in similar circumstances.

II.—INJURIES OF THE SCROTUM AND TESTICLES.

Let us mention first of all, **dislocation of the testicle** without an external wound: this is a very uncommon condition, but must not be overlooked because of its rarity: after a violent blow on the scrotum, a fall astraddle, or an injury inflicted by a rolling body, the testicle has

[1] Poncet, "Étranglement de la verge par une massette en acier trempé." *Bull. de la Soc. de chir.*, 16 déc. 1891, p. 756.

been found projected out of the scrotum, under the skin, to the side of the penis, or into the pubic or inguinal regions.[1]

An examination of the scrotum—which should always be the first care of the surgeon after these perineo-scrotal injuries—shows that one side is empty: the testicle is no longer there; on seeking for it in the neighbouring regions, it is found in the form of a very tender, ovoid, mobile mass (with the special testicular tenderness), the nature of which is usually recognized without difficulty.

The displaced organ *must be reduced*, and as soon as possible: reduction is the only means of relieving the pain, which is usually very severe, and of preventing the formation of adhesions which may speedily render replacement impossible. General anæsthesia will often be necessary. With regard to the method of reduction, it is scarcely possible to lay down any definite rules; one must endeavour by gentle pressure to push the dislocated testicle back into the scrotum along the line it took in escaping from its proper position.[2]

If all attempts by external manipulations fail, then recourse must be had to *open reduction*; after having submitted the whole region to a careful preparation, the testicle will be exposed by an incision extending to the corresponding side of the scrotum; the organ will then be liberated, and made to traverse the road along which it had come, and if necessary, the operation may be completed by orchidopexy.

Amongst the various **open injuries** (incised or contused wounds, lacerations, gunshot wounds), for purposes of treatment, we can distinguish the three following types:—

1. **Wounds of variable extent and depth, without Dislocation or Grave Lesion of the Testicle.**—What we shall have to say further on with regard to wounds of the soft tissues is here in all respects applicable: some special details alone need consideration.

The mechanical cleansing of the scrotum must always be executed with the utmost care: hair shaved, prolonged washing with soap and warm boiled water, without antiseptics; the scrubbing must be done gently, to avoid irritating the tender and easily injured skin of the region.

If the lesion is an incised wound, it will be reunited, the edges being everted and carefully adjusted; and the sutures must not be tied too tightly. In cases of contused wounds or crushes, one must generally be content with enveloping the parts in moist aseptic compresses; however, when dealing with flap wounds, even if lacerated, it is always advisable to readjust the detached tissues and to fix them in place with a few sutures.

[1] See Maurice Nicolas, *Luxation traumatique du testicule*. Thèse de Paris, 1899.

[2] Hess's patient (quoted by Nicolas, *loc. cit.*) had been thrown to the ground from an ammunition wagon on which he was seated: he had fallen flat on his abdomen, with his sword between his legs. The right side of the scrotum was empty; the testicle was found, on the inner aspect of the thigh about an inch below the fold of the groin, in the form of a very painful lump about the size of an almond. To reduce it, "the organ was pushed directly upwards, then insinuated through the artifical opening that it had made, and finally was replaced in the scrotum."

When the tunica vaginalis is involved, it will, after very thorough cleansing, be closed by a continuous suture of fine catgut (*Fig.* 74), leaving a small drainage tube at the lower angle of the wound if necessary, if the injury is not quite recent or if the parts are very dirty.

Finally, it may be that the testicle itself is injured and that a little reddish-brown mass of testicular tissue is protruding through the capsule : remember that the entire contents of the tunica albuginea may be extruded through a very narrow slit, but that it is particularly in cases where the wound remains infected and suppurates, that such a condition ensues. It is therefore always well to suture the opening in the tunica albuginea, replacing the protruding parenchyma with a director or the end of a small spatula. If the herniated mass is blackish and dirty, excise it with curved scissors and touch the bleeding points with the thermo-cautery ; then, using a fine curved needle, introduce a series of interrupted sutures, Lembert fashion, in the edges of the wound in the tunica albuginea, which is smooth, dense, and always rather difficult to penetrate ; tighten the sutures slowly and without constricting the tissues. This requires care and some deftness ; but it is usually possible to bring the opposing surfaces into satisfactory contact ; however, should it be found too difficult to get the sero-serous surfaces together, it may suffice to approximate the edges of the opening by means of a continuous suture (*Fig.* 74). The important point is to close the opening and, above all, to maintain asepsis.

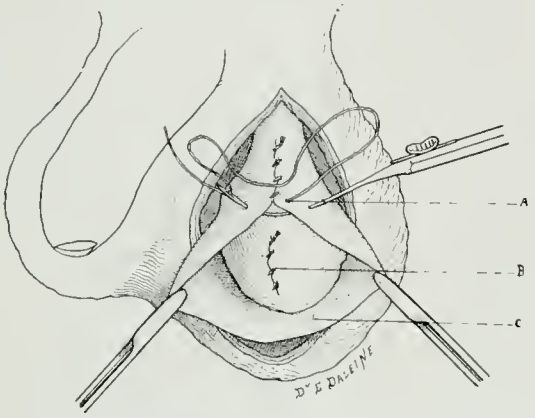


Fig. 74.—Wound of the scrotum, tunica vaginalis, and testicle. The wound in the tunica albuginea has been closed ; closing the wound in the tunica vaginalis. (A) Suture of the tunica vaginalis. (B) Suture of the tunica albuginea. (C) Vaginal sac held widely open.

2. **Wounds Complicated by Dislocation of the Testicle.**—The wound is most often caused by a crushing or tearing injury, and is sometimes comparatively small ; but from it the testicle protrudes, and hangs exposed along the thigh. The chief object is to return the organ to its place and secure it there. Begin—before any exploration or attempt at reduction—by cleansing the testicle, cord, scrotum, and the whole of the surrounding region ; make sure that the gland is intact or, at least, that it presents only minor and reparable lesions ; that the stretched cord is neither torn nor twisted ; then carry out at once any necessary reparative measures—suture of the tunica albuginea, ligature of bleeding vessels, etc.

Do not try to reduce the testicle by force, through a wound too small

to allow the organ to pass readily ; enlarge the wound,[1] upwards or downwards as is most convenient, and by means of the larger opening thus provided complete the cleansing of the deeper tissues.

Define the edges of the testicular coverings and secure them with forceps : when the testicle was extruded from the scrotum all its envelopes were turned inside out ; to try to replace the organ forcibly and by chance, is a difficult and useless undertaking ; there is no longer an actual cavity to receive it, but **there is a potential cavity, the vaginal sac,** which will be reconstituted if one finds its wall, restores its natural relationships, and insinuates the testicle through the opening in it.

Of course the envelopes are often, in large degree, destroyed or rendered unrecognizable by the primary injury ; further, if the accident is not quite recent, the cord and testicle may be so much swollen that there is no room for them in the retracted scrotum. However, an endeavour must always be made to find the remains of the serous coat by following the cord, and to replace the testicle in the midst of them, as the fragments of the tunica vaginalis should always form part of the new intra-scrotal pocket into which the testicle is placed.

Indeed, though in quite recent dislocations it is sometimes possible to replace the testicle entirely in its own serous cavity, and to restore the wall by means of a continuous suture, more frequently the surgeon will need to be satisfied with covering up the organ with the other envelopes and the skin.

Therefore try to enclose the testicle in the best way possible and with whatever is available ; but do not be disturbed if the necessary tissue is lacking, or cannot be adapted to the purpose in view. Apply a moist aseptic dressing and wait. Within a few days the congestion will disappear, the tissues will relax, and things will arrange themselves beyond all expectation. Irreducibility—in other words, the impossibility of at once providing a complete covering for the testicle—is never an indication for primary castration, if the organ and its vascular supply are intact.

3. **Wounds Complicated by Irremediable Lesions of the Testicle, whether Dislocated or not.**—Conservative measures are inapplicable to cases which have received no proper attention, and in which the testicle has been exposed for a considerable time, and is consequently shrivelled, dry, and black ; or where the cord is almost completely ruptured, or when the testicle has been extensively damaged, and the parenchyma having been lost, has to a large extent emptied itself, and the organ is reduced to an empty fibrous shell ; and above all, when the wound is infected, and threatening septic symptoms are present.

The removal of a testicle which is hopelessly damaged and a source of danger is an immediate necessity : tie the cord as high up as possible, and cut it below the ligature.

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[1] Malgaigne laid down this rule in 1847 (" De la hernie traumatique du testicule." *Revue médico-chir.*, février, 1847).

The ligature ought to be interlocked and tightly tied: take a thread of thick catgut or silk; without dissociating the constituent parts of the cord, perforate it with an aneurysm needle or the end of a pair of forceps; draw the loop of the ligature through the cord, bring the ends round, and tie them with a Lawson Tait's knot; or again, and more simply, if not accustomed to using this excellent knot, pass the catgut or silk through the centre of the cord, tie one of the halves firmly, then carry the two ends round the other half, and tie them with the same care as before (*Fig.* 75).

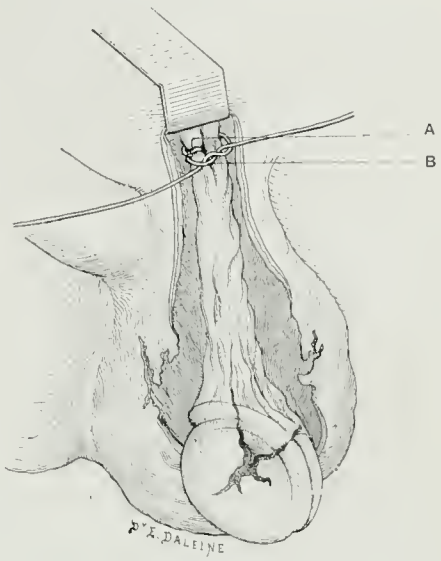

Fig. 75. Castration. Ligating the cord. (A) Ligature around one-half of the cord. (B) Ligating the other half with the same thread.

A ligature tied in this way will not slip, and the cord may be boldly cut a quarter of an inch lower down without troubling to secure the vessels separately in the face of the stump. Do not cut the ends short until after dividing the cord, and until assured that there is no bleeding and that the ligature is secure; as soon as the ends are cut, the stump of the cord slips up and disappears.

It then only remains to repair the scrotal lesion in the best manner possible, excising any lacerated and useless tags of tissue.

TORSION OF THE SPERMATIC CORD.

Though this is an uncommon accident, it must be mentioned and briefly described; it often simulates strangulated hernia, and, like the latter condition, requires immediate operation.

The following case reported by Dujon and Chégut,[1] will serve to show how *torsion of the cord* presents itself.

The patient was a lad 14 years of age, previously healthy and without any testicular abnormality; after a ride on horseback, followed by a drive in a carriage, he was attacked with colicky pains, and the left side of the scrotum was found to be considerably enlarged. Eight days later the symptoms became aggravated: there was abdominal distention and

[1] Dujon et Chégut (of Moulins). "Un cas de bistournage spontané du testicule simulant une hernie étranglée." *Arch. prov.. de chir,* octobre, 1900, No. 10, p. 653.

obstruction, neither fæces nor flatus being passed; the left side of the scrotum and the anterior wall of the inguinal canal on the same side were distended with a prominent, pear-shaped mass with the larger extremity downwards, very painful and dull on percussion. A diagnosis of strangulated hernia was made, and operation was performed forthwith.

An incision was made over the inguinal canal and the upper part of the scrotum: an elongated pear-shaped mass, with no resemblance to a hernial sac, appeared; at the lower part of the mass there was a distended, thin-walled, and fluctuating portion; this was incised. A wine-glassful of lemon-yellow fluid escaped, and then a blackish mass, which could be recognized as the testicle, appeared. At the upper border of the organ there was a narrow pedicle, twisted on itself. The pedicle was untwisted, and it was found that there were two turns in the direction of the hands of a watch. The testicle was replaced in the tunica vaginalis, which was then sutured. The rest of the swelling was simply due to œdematous infiltration of the spermatic cord.

A portion of the testicle sloughed, and some days later was thrown off after the formation of a small abscess. After the wound had healed, the testicle was represented only by an irregular nodule about the size of an almond.

In this instance the torsion had affected a "descended" testicle occupying a normal position at the bottom of the scrotum, and similar cases have repeatedly been observed; but the accident occurs more often in cases where the testicle is abnormally placed, and is sufficiently explained by the unnatural mobility of these misplaced organs.[1]

There is *an incomplete and spontaneously curable form* of spermatic torsion; we have seen an instance in a young man 26 years of age; he had been suddenly seized with an intense pain in the sub-umbilical region; he turned pale, almost fainted, and had to lie down; the pain radiated into the inguinal region and over the lower portion of the abdomen; the anxiety of the patient (a medical man) was extreme, as he thought himself to be affected with obstruction or internal hernia. The left side of the scrotum very speedily became considerably swollen, and the swelling extended along the cord above Poupart's ligament. The testicle was in its proper place; it seemed to be a little enlarged, but was so extremely sensitive that an examination was almost impossible; the abdominal wall over the iliac fossa was tense and "defended itself" against the slightest touch. The pulse was full and a little accelerated, the temperature normal. The symptoms only lasted for a very short time; at the end of three hours all had disappeared. These transitory and benign crises are liable to recur; it is even said that some individuals have learnt to untwist their own cords.

[1] According to MM. Sébileau and Lapointe, two varieties of torsion must be distinguished: *torsion proper* and *volvulus*. By torsion is meant a twisting of the testicle and its fibro-serous coverings en masse; it is uncommon, and the twist is usually situated high up, towards the inguinal canal; more often, however, the testicle is rotated on itself within the vaginal sac; the condition is then a volvulus, and the twisted pedicle corresponds to a low segment of the cord, of variable length. Clinically, a diagnosis between the two varieties is almost always impossible. (See Lapointe, *La torsion du cordon spermatique et l'infarctus hémorragique du testicule*. Paris, 1904)

In *the grave form*, the onset is always sudden : the pain is most intense, and above all lasting : the picture is completed by the appearance of **local inflammatory signs,** swelling of the scrotum, extending upwards to a variable level, redness and œdema, and by **abdominal symptoms,** vomiting, intestinal obstruction, and distention.

It is evident that an acute orchitis or strangulated hernia may be simulated, according as one or the other of these two groups of symptoms predominates ; further, though the condition may be ascribed to some violent movement such as a fall, a jump, or a strain, etc.,[1] there has been no injury properly so called. On the other hand, the œdematous swelling of the cord, extending upwards into the inguinal canal, may very easily be mistaken for the pedicle of a hernia ; and when the twisted testicle is abnormally placed, in the sub-inguinal or interstitial regions, confusion is almost unavoidable. However, the suddenness of the onset, the severe pains, the always incomplete fæcal obstruction, and the local inflammatory signs, are sufficient to arouse doubts as to the nature of the condition.

Even if a diagnosis of torsion of the spermatic cord can be made with certainty, immediate operation is none the less necessary. Immediate action is the only means of cutting short the march of symptoms and, if still possible, of saving the testicle.[2]

Untwisting by external manipulations may be tried[3] in quite recent cases, but can scarcely be depended on, and operation is almost invariably necessary.

An incision is made in the inguino-scrotal region, and the reddened and œdematous tissues are divided layer by layer, until a tense sac is exposed ; the sac is opened like a hernial sac, and emptied of the blood-stained fluid which it contains ; the testicle, more or less distorted and unrecognizable, is found, and above it the twisted pedicle. Secure more room if necessary by extending the incision upwards, and proceed to reduce the torsion, usually by turning the testicle from right to left. If the deep violet colour of the congested testicle becomes paler after the cord has been untwisted, it is a good sign ; the organ will be preserved and fixed to the postero-inferior part of the tunica vaginalis by a few catgut sutures. If the testicle is black, lustreless, and hard, or if there are already some brownish necrotic patches, then it must be sacrificed. Conservative measures ought to be

[1] A young man, operated on by Tuffier, had succeeded, five months previously, in bringing his testicle down into the scrotum by repeated massage. While straining during defæcation, he was suddenly seized by pains comparable to those of strangulated hernia, and at the same time the testicle slipped back to its former position in the inguinal canal. Five days later Tuffier made a diagnosis of torsion of the spermatic cord, and at the operation found the cord twisted and the testicle blackish in colour and becoming gangrenous ; it was necessary to remove the organ (Tuffier, "Gangrène par torsion du cordon d'un testicule en ectopie inguinale" *Bull. Soc. de méd.*, 30 mai, 1903, p. 551).

[2] From Enderlen's investigations it would appear that if the circulation in the cord has been interrupted for twenty-two hours, ultimate atrophy of the testicle is inevitable. Enderlen, "Klin. und experim. Studien zur Frage der Torsion des Hodens." *Deutsche Zeitschrift f. Chir.*, 1896, Bd. xliii, p. 177).

[3] See J. Vanverts, La torsion du cordon spermatique (bistournage spontané). *Annales des mal. des organes gén.-urin.*, 15 mars, 1904.

pushed as far as possible ;[1] it may happen that a portion of an organ which has been retained may actually slough and be subsequently eliminated ; it is therefore advisable, if the condition of any part of the organ is doubtful, to drain the vaginal sac and to leave the channel open.

PARAPHIMOSIS.

The Accident is Recent ; the swollen and congested glans is encircled at its base by a thick collar, extending like a frill to the under surface below the frænum ; but this collar is œdematous, soft, and still depressible. In reality, there are two closely placed collars on the dorsal surface, the one anterior and mucous, the other posterior and cutaneous : separate them, and between there will be seen a circular groove, the constricting ring, deeply situated but still intact.

Reduction can be effected without much trouble if undertaken in the right way. Here as everywhere else the first step in reduction consists in reducing the volume of the herniated organ ; the glans penis is herniated through a narrow preputial orifice : *begin therefore by compressing the glans.* Dismiss at once all those irrational and brutal measures which consist essentially in seizing the penis in the whole hand and forcibly dragging the teguments from behind forwards. Do not try to replace the glans with a single movement ; return it gradually and methodically under its preputial covering.

Surround the swollen glans with a compress moistened with cold water, or better with a 1 per cent solution of cocaine, and through the gauze covering compress the organ from before backwards and all round ; after the pressure has been maintained for a few minutes, the glans will be less tense and somewhat smaller. This preliminary massage may with advantage be continued for five or ten minutes.

Then, with the fingers of the right hand disposed around the organ as in *Fig.* 76, push the preputial collars from behind forwards, trying to make them slip over the base of the glans, which is simultaneously compressed and pushed backwards by the fingers of the left hand ; or better still, direct all efforts primarily to one segment only of the corona which is compressed by the left thumb ; as soon as the difficulty is overcome at one point of the circumference, the rest follows. Another method : take the penis between the index and middle fingers of both hands, with the palmar surfaces directed towards the glans, and, while trying to draw the prepuce forward, push the glans backwards by methodical pressure exerted

[1] Castration has, however, been necessary in the majority of cases; out of 37 cases collected by M. Lapointe (*loc. cit.*), castration was done in 26 and conservation attempted in 11 ; of these 11 cases, in six the testicle subsequently sloughed, and in the five in which the organ was preserved it underwent more or less atrophy.

with the thumbs, first of all, in the neighbourhood of the corona, and afterwards at the apex. This is also a good way of completing reduction when the constricting rings have begun to yield and to roll forward.

The Condition is of Longer Standing.—Reduction is much more difficult in cases of paraphimosis of considerable standing, with enormous hard, adherent preputial collars, and with an ulcerated and bleeding constricting ring.

The condition of the penis always looks more alarming than it actually is, and if the trouble is a simple paraphimosis without a complicating chancre, the pseudo-strangulation of the glans will never cause extensive necrosis. However that may be, one must never wait for ulceration and destruction of the constricting ring to cure the condition.

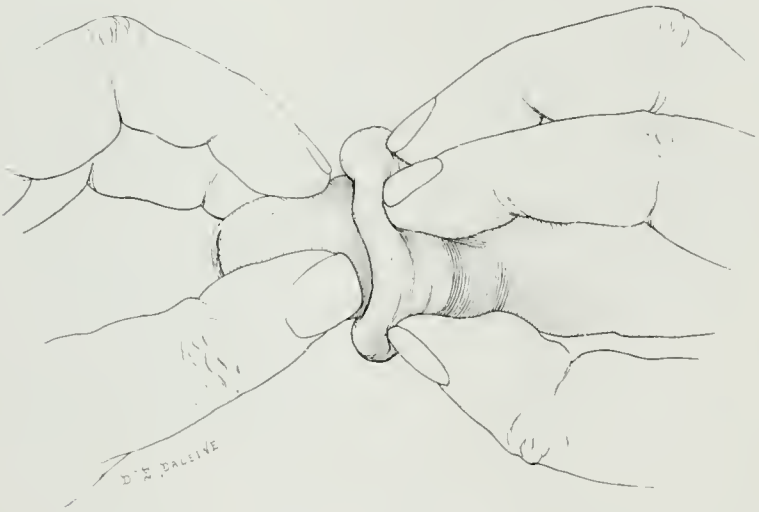

Fig. 76.—Reducing a paraphimosis.

Therefore try to effect reduction; with some persistence success is often possible even at this late stage. Make the attempt in the manner already described, giving ample time to each successive step, prolonging the preliminary compression of the glans, and the compression, unfolding, and pushing forward of the retracted prepuce. It is neither an easy task nor an elegant method; however, do not hurry: after all, nothing presses, and if the attempt does fail, there is a very simple measure whereby the condition can be remedied.

A small longitudinal incision, or a snip with the scissors in the middle line on the dorsum of the penis, dividing the anterior mucous collar and the mucocutaneous constricting ring, will usually give sufficient relaxation to allow of reduction.

If it is necessary to have recourse to cutting instruments, then instead

of leaving a torn, deformed, and thickened prepuce, the lower portion of which will remain swollen and troublesome for a long time, the better plan is to excise it at once : that is, to perform circumcision.[1]

Wash the whole penis carefully with soap and warm boiled water, then inject 4 cc. of a 1 per cent solution of cocaine, in a ring around the root of the organ. At the end of four or five minutes, the analgesia will be sufficient.

The median dorsal section has just been made (*Fig.* 77) : secure each of the two lateral flaps with a pair of Kocher forceps, turn them outwards as far as the œdema permits, and, without stretching them, divide each at its base back to the frænum with curved scissors (*Fig.* 78).

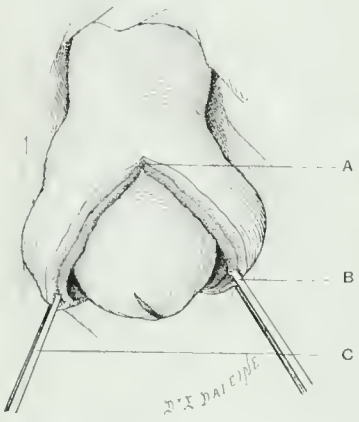

Fig. 77.—Excision of the prepuce in a case of paraphimosis. Median dorsal section. (A) Median dorsal section. (B, C) The two lateral flaps held with forceps.

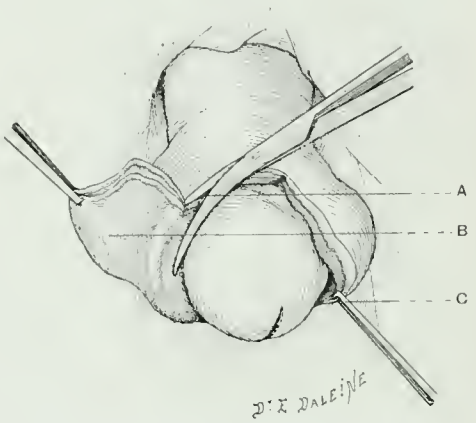

Fig. 78.—Excision of the prepuce in a case of paraphimosis. Excision of the two lateral flaps. (A) Curved scissors excising the right lateral flap. (B) Flap held in an everted position by the forceps. (C, Left lateral flap.

Then on either side unite the cut edges of the two layers by means of a continuous suture of fine catgut : do not draw the sutures too tight, or gangrene may easily be induced owing to the impaired vitality of the tissues, but try nevertheless to get accurate adjustment (*Fig.* 79).

Lastly, the swollen tissues immediately behind the frænum require attention : cut the swelling transversely, or better, excise a transverse bridge ; do not be afraid of making a fairly free incision or excision ; if the glans is markedly curved downwards, after having made the cut in a transverse direction, unite the edges longitudinally (*Fig.* 80).

In some cases it is impossible to obtain sufficient relaxation of the constriction to enable reduction to be effected ; it then becomes necessary to excise the prepuce in its abnormal position.

[1] *See* E. Peltre, *Traitement du paraphimosis par la circoncision d'urgence.* Thèse de Paris, 1899.

A first circular incision is made immediately in front of and parallel to the anterior swelling, commencing in the middle line on the dorsum of the penis, and crossing the frænum on the under surface ; on the skin surface, behind the constricting groove, a second circular incision is made parallel to the first ; the two are joined on the dorsum by a longitudinal cut, and the two segments of the prepuce thus marked out are dissected up on either side. Care must be exercised to remove, with the skin, a wedge of the underlying infiltrated and œdematous cellular tissue.

Once this excision is completed, the prepuce, and with it the paraphimosis, have disappeared ; it only then remains to unite the cutaneous and mucous edges by a series of interrupted sutures of silkworm gut or

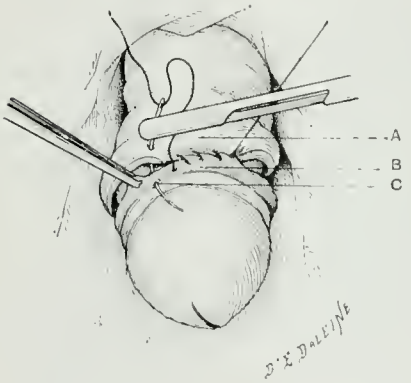

Fig. 79.—Excision of the prepuce in a case of paraphimosis. The mucocutaneous continuous suture. (A) Skin. (B) Edge of the mucous layer. (C) Needle introducing the continuous mucocutaneous suture.

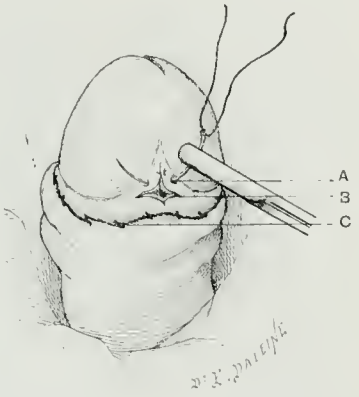

Fig. 80.—Excision of the prepuce in a case of paraphimosis. Suturing the edges of the gap left by the excision of the swelling behind the frænum. (A) Suturing the gap left by excision of the swelling behind the frænum. (2) The transverse excision. (C) Continuous mucocutaneous suture.

catgut, or better still by a continuous suture of fine catgut, interrupted two or three times, in order to be able to tighten it sufficiently without at the same time puckering the circumference of the new preputial orifice.

This simple and radical operation is terminated by the application of a moist dressing, and rapid healing is speedily obtained.

ABSCESS OF THE PROSTATE.

A young man, during or after an attack of gonorrhœa, is taken ill with fever, shivers, acute pains in the perineum, the anus, and the penis ; micturition is difficult, and defæcation is associated with intense suffering, while rectal tenesmus is almost continuous. The symptoms become steadily worse without any remission ; at the end of a few days the perineum is found to be swollen and tense ; the skin is slightly reddened, thickened, and œdematous.

The introduction of a finger into the rectum is attended with great difficulty, and causes intense pain : on the anterior wall of the bowel a large swelling is found ; this is asymmetrical, is more developed and *more prominent over one lobe of the prostate than the other* ; it is superficially œdematous, more or less definitely fluctuating, and is surrounded by a wide area of inflammatory thickening which extends to the sides of the rectum and down to the anus.

The condition is urgent : the diagnosis is perfectly evident ; even the position for the necessary incision is clearly indicated.

There is a prostatic and periprostatic abscess extending towards the perineum : *it is by the perineum that it must be opened* at once and drained freely, in the manner to be immediately described.

Fig. 81.—Digital examination of the prostate by the rectum. (The index finger is protected by a rubber finger-stall, and surrounded at its root by a gauze compress.)

The perineal operation is essential in dealing with these extensive suppurations, even when the urine contains pus and the abscess has evidently already opened into the urethra ; the drainage by the latter channel is always inadequate, and free opening up of the inflammatory focus is the sole means of preventing wide extension of suppuration and the formation of secondary abscesses.

Another and more common form. The local and general symptoms are less serious ; the suppuration is confined to the prostate and the prostatic pouch, and there is extension towards the perineum. Rectal examination (*Fig.* 81) reveals a rounded swelling of one of the prostatic lobes, of variable size ; sometimes it may be very large, soft, fluctuating at the centre, and indurated at the periphery ; but the inflammatory infiltration does not extend far beyond the purulent focus.

Here again the diagnosis of prostatic abscess is perfectly clear, and the indications, though less urgent, are quite as definite as in the other form. The abscess must be incised for the purpose of relieving the characteristically intense lancinating pains, to check the advance of suppuration, and to prevent the opening up of tissue-planes and the formation of fistulæ.

In the presence of such extensive suppuration no dependence can be placed on the possibility of cure by spontaneous opening of the abscess into the rectum or urethra. One cannot deny that small accumulations

reach a favourable termination in that way, but in the case of a large prostatic or periprostatic abscess the opening is always too small, and the relief which follows the rupture is only transitory, and is speedily succeeded by fresh complications.

Nor, again, can the opening of an abscess, which is bulging into the urethral canal, with a catheter, be considered as a rational therapeutic measure. Retention of urine is a not uncommon complication of suppurative prostatitis: passing a catheter may possibly rupture the abscess and the pus may escape along with the urine. This is a fortunate chance, nothing more; to attempt deliberately to do it is an uncertain and dangerous practice.

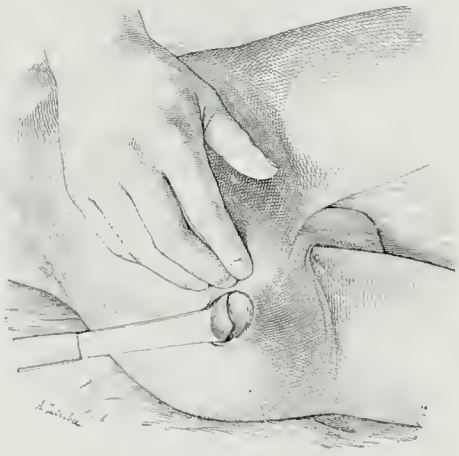

Fig. 82.—Direct examination of the prostate by the rectum.

There are therefore only **two available routes: the rectum and the perineum.**

The old method of blind rectal puncture on the finger should never be attempted; its apparent simplicity masks too many dangers. Remember that very serious and alarming hæmorrhages have occurred after these "exceedingly simple" measures; remember that such accidents cannot be prevented by determining the position of the pulsating rectal arteries and making the puncture between them, for the prostate is surrounded by a network of large veins, and the diffuse oozing, which can easily be checked when visible to the eyes, may be a serious danger after a puncture made at a guess.

The same objections do not apply to **incision by the rectum**;[1] in certain cases a rectal incision is the natural method of dealing with the abscess, under the express reservation that it is made under the guidance of the eyes, and that the anterior rectal wall is well exposed.

Let us presume that we have to deal with a definitely circumscribed abscess of one of the lateral lobes of the prostate, bulging into the rectum, softened and fluctuant at the centre, and without much peripheral infiltration. The perineum is not affected, the abscess is situated well above it and is pointing in the rectum. In such a case incise it by the rectal route as follows:—

Have the patient anæsthetized. Place him on his right side, with the

[1] See Lafont, *Traitement des abcès chauds de la prostate par l'incision rectale.* Thèse de doctorat, Paris, 1895; and a lecture by Routier: "Causes et traitement des abcès chauds de la prostate." *Presse médicale*, 14 février, 1900.

right thigh extended and the left thigh flexed and raised by an assistant, and the anal region well exposed in a good light. First, dilate the anal sphincter moderately, and irrigate the lower bowel thoroughly with warm boiled water ; introduce the blade of a retractor as far as possible into the

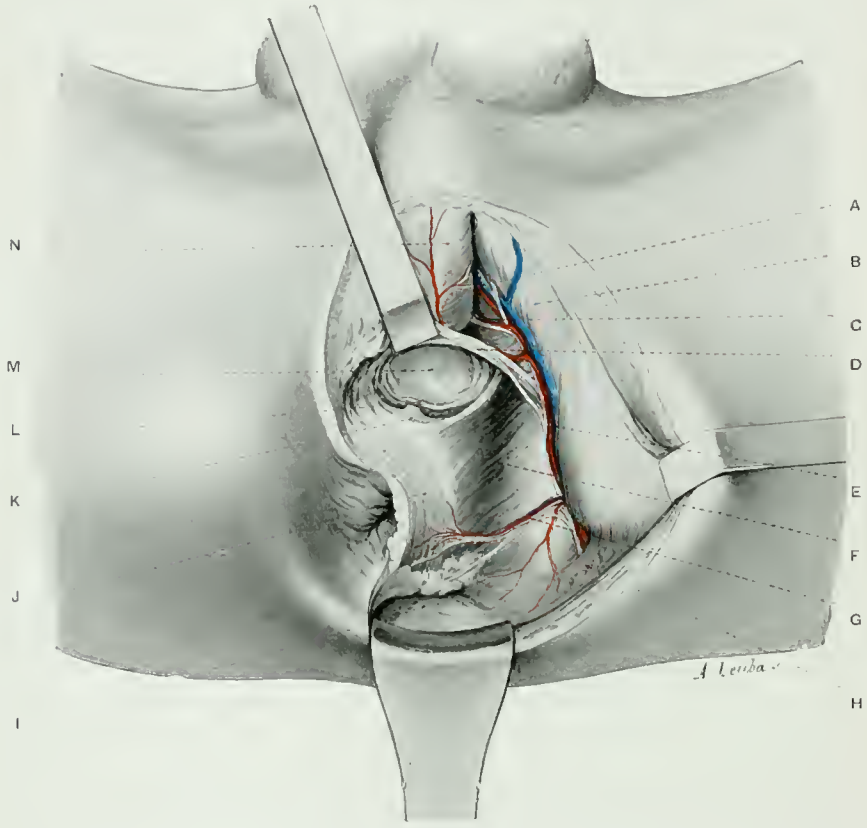

Fig. 83.—Perineal region. (A) Superficial perineal artery. (B) Ischio-cavernosus muscle. (C) Inferior branch of the internal pudic nerve. (D) Superficial transverse perineal muscle. (E) Internal pudic vessels and nerve. (F) Levator ani muscle, bounding the ischio-rectal fossa on the inner side. (G) Inferior hæmorrhoidal artery. (H) Lower border of the gluteus maximus. (I) Ano-coccygeal space. (J) External sphincter of the anus. (K) Ano-bulbar raphe, divided. (L) Recto-urethral muscle, divided. (M) Posterior surface of the prostate. (N) Bulbo-cavernosus muscle.

rectum, and retract the posterior wall of the bowel to expose and stretch the prostatic wall (*Fig.* 82).

The swelling is now visible ; do not be surprised at finding that it is less prominent to sight than it had appeared to be on digital examination ;[1]

[1] This apparent diminution in size is constantly observed after anæsthesia, and is to be explained by the relaxation of the periprostatic muscles, particularly the levatores ani. Care must therefore be taken, before anæsthetizing the patient, to explore the field thoroughly and to determine the position of the fluctuating area.

palpate it afresh, and then thrust the point of the knife boldly into the centre to a depth of half an inch ; the pus escapes along the blade ; extend the incision downwards for a distance of at least three-quarters of an inch to an inch.[1]

Now the edges of the opening are held apart and the pus is allowed to run away, the escape being helped by gentle pressure with the finger ; the cavity is cleansed by irrigating it with warm boiled water.

The operation may be terminated at this point, and, leaving nothing in the rectum, the operator contents himself with administering copious rectal injections several times daily. But if the cavity is deep, or if there is any oozing, it is better to pack it with a strip of aseptic gauze ; the packing will generally be expelled with the first movement of the bowels.

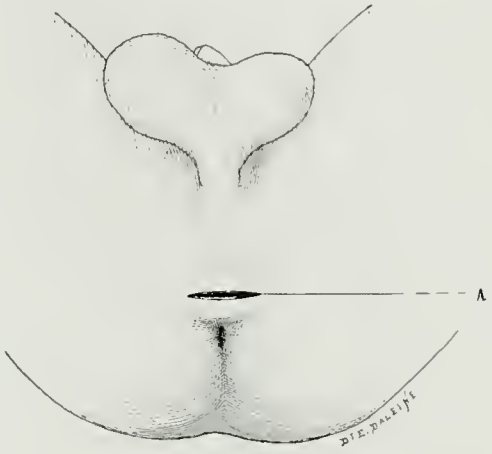

Fig. 84.—Perineal incision of a prostatic abscess. (A) Transverse pre-rectal incision.[2]

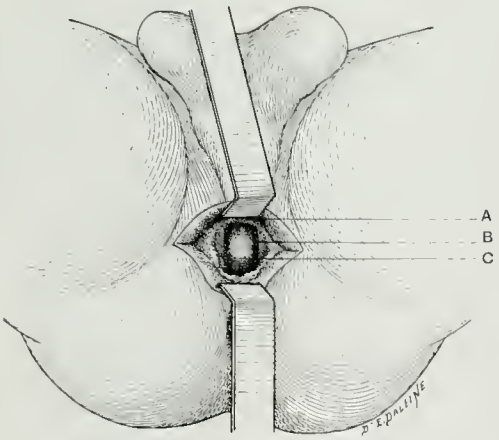

Fig. 85.—Perineal incision of a prostatic abscess. Exposure of the prostatic space. (A) Retractor drawing the urethral bulb forwards. (B) Margins of the levatores ani. (C) The prominence caused by the periprostatic abscess.

Of course, if a vessel of any size is wounded, the bleeding will be checked forthwith by forceps and ligature. Apart from the cases in which the abscess is pointing in the rectum, a **perineal incision** is the method of choice for dealing with extensive prostatic or periprostatic suppuration. It discounts the danger of hæmorrhage or secondary infection, it provides free access to and good dependent drainage of the prostatic pouch, and thus prevents secondary extensions and the formation of fistulæ. And indeed it is not a difficult operation requiring a highly specialized technique.

[1] If there is an abscess in each lobe, they will of course be opened by separate incisions. According to Routier, the two foci are always independent.

[2] It will be better to curve the extremities of the incision a little backwards.

Incise the perineum transversely, between the sphincter ani and the bulb (*Fig.* 84), and work steadily onwards along the anterior rectal wall: this must necessarily reach the prostate and the abscess (*Fig.* 85).

The patient is anæsthetized, then placed and secured in the lithotomy position: the rectum is washed out and the field of operation submitted to the usual preparation. Make a *transverse incision across the perineum* a finger's breadth in front of the anus, from one ischial tuberosity to the other;[1] cut boldly through the skin and superficial planes; there is no vessel of any size to be feared; define the bulb of the urethra, the anterior fibres of the external sphincter and the ano-bulbar raphe, which becomes tense and prominent when the posterior edge of the wound is retracted. Divide the raphe transversely, and draw the bulb forward under a retractor; the prostate is not yet reached, nor the separable tissue-plane which will lead to it; it is the inner borders of the reddish-coloured levators which are exposed, and between them a greyish-coloured sheet with antero-posteriorily directed fibres (the recto-urethral muscle);[2] pick up this layer with the forceps and cut it close to the bulb; now the way is open. Lay aside the knife, and with the director enlarge the breach which has just been made, from before backwards, employing the left index finger as a guide to the underlying inflammatory mass.

When there is extensive periprostatic suppuration, or a large abscess in the prostate, the pus is generally very soon reached: enlarge the opening with the finger and the director, explore the cavity gently, and seek for any diverticula which may be present.

In many cases the whole operation can be performed quite satisfactorily without any intrarectal manipulations, but if the abscess is at all high up, a finger in the rectum will be a great help. Make the transverse perineal incision, and open the space between the bulb and the anus; then put a glove on the left hand, pass the index finger into the bowel, and hook it above the upper border of the swollen prostate, which can then be fixed and depressed towards the right index and the director working in the perineal wound. As soon as the pus has been reached, the rectal finger will be withdrawn, the glove removed and the hand carefully cleansed, before proceeding with the operation.

When the pus has been evacuated, it only remains to wash out the cavity, to place a drainage tube in it, and to apply a firm dressing over all.

[1] It will be better to curve the extremities of the incision a little backwards.

[2] *See* Robert Proust, *Manuel de la prostatectomie périnéale pour hypertrophie.* Paris, 1903.

SECTION VIII.—THE RECTUM AND ANUS.

ANO-RECTAL IMPERFORATIONS.

On the 5th November, 1894, I was called in the evening to the Enfants-Malades Hospital to see a little girl two days old, who had just been admitted. The bowels had not been moved; during the day she had repeatedly vomited yellow liquid material, and the abdomen had become more and more distended: a doctor had recognized that the rectum was imperforate.

Case 10.—The child was fairly well made, but was very pale, and the face was pinched; the abdomen was distended and it was impossible to determine anything exactly by palpation. On examining the ano-perineal region, I found a small blind depression bordered with puckered skin and which barely admitted the tip of the little finger, in the position where the anus should have been. The urine was of normal colour, and there had been no discharge of meconium from the vagina.

The condition was therefore one of imperforation, probably simple and without any abnormal opening of the terminal portion of the intestine. But to what height did the deficiency ascend? The examination furnished no definite information with regard to this point. The perineum was of average width, and the ischia were placed no closer than usual; when the child cried *no prominence made itself evident*, and *the finger could not detect the slightest impulse at the bottom of the depression*. Where was the rectal ampulla situated? We could not say.

The infant was placed on its back with the legs raised and separated, the pelvis elevated, and the perineum exposed in a good light. A few drops of chloroform were very cautiously administered.

A median antero-posterior incision was made from the fourchette to the tip of the coccyx, which could be felt fairly easily; the centre of the incision passed through the anal depression. Under the skin we encountered some reddish fibres, which were separated and retracted carefully to either side; we penetrated into a fatty layer, which was cautiously opened up, first with the scalpel and then with the director and the finger. The coccyx came into view posteriorly, and to give more room its lower portion was excised; the further explorations were therefore pursued in the pre-coccygeal area.

We reached a depth of nearly two inches, feeling all the time for the sensation of a tense elastic sac, looking for some blackish-coloured area which might indicate the blind end of the gut. Finally we discovered *a sort of rounded swelling, dark-coloured and fluctuating*, which seemed to be quite characteristic. The sac wall was secured with two pressure-forceps and, after continuing the separation gently with the finger, the bowel was freed sufficiently to allow it to be brought down a little. But during the manipulations the wall tore under the jaws of one of the forceps, and a stream of meconium escaped and continued to flow for several minutes. After the discharge ceased the whole area was cleansed with warm boiled water and the work of separation was continued.

The skin at the anal margin was freshened, and the rectal mucosa attached

to it by a series of interrupted sutures of catgut ; the two extremities of the incision were sutured in their turn, so forming the anal canal. A dressing of sterilized gauze and wool was then applied.

The child made an uncomplicated recovery. At first there was a tendency to prolapse of the rectal mucosa, but that speedily disappeared. Five months later the anus was acting perfectly, and the infant was in excellent health. I have seen her since, and she remains in a perfectly satisfactory condition.

This is, if I may say so, a typical case and an excellent example of the form in which this congenital abnormality most often shows itself.

In such a case the diagnosis and the immediate indications are clear.

Let us add that it ought to be an absolute rule to examine the natural orifices of every new-born infant ; if that were done as a routine practice,

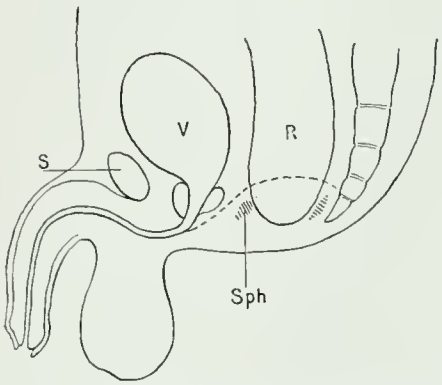

Fig. 86.—Ano-rectal imperforation (1st type). The imperforation is limited to the anus.[1]

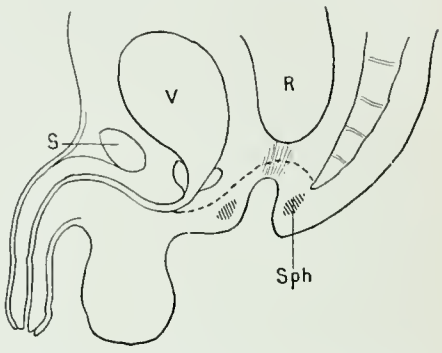

Fig. 87.—Ano-rectal imperforation (2nd type). The anus is formed ; there is an ano-rectal septum.

(S) Symphysis. (V) Bladder. (R) Rectum. (Sph) Anal Sphincter.

those operations, which are every now and again performed on the fifth or sixth day, even a fortnight after birth, and with the patient in a condition of stercoræmia, would be avoided.

If the imperforation has not been recognized immediately after birth, it is soon observed that the infant's bowels have not acted ; by the second or third day all the symptoms of intestinal obstruction appear : meteorism, which is often very great, vomiting of yellowish material (meconium), respiratory distress, pinched face, coldness of the extremities.

On examining the anal region, one or other of the following conditions is found :—

1. *The anus is absent* ; it is replaced by a blind depression, sometimes scarcely evident, or even by a prominent ridge continuous with the perineal raphe (*Fig.* 86).

2. *A well-formed anus is present*, but at a variable depth, an inch, an inch and a half, or more, the finger is arrested by a partition forming a complete diaphragm (*Fig.* 87).

[1] *Figures* 86, 87, and 88, as well as *Figs.* 97, 98, and 99, are taken from the article by Rudolf Frank, *Ueber die angeborene Verschliessung des Mastdarmes und die begleitenden inneren und ausseren angeborenen Fistelbildungen.* Vienna, 1892.

I presume that the complete examination, to which I shall return later on, has demonstrated the absence of any abnormal communication of the bowel, and shall afterwards refer to the exceptional conditions in which the barrier is situated too high to be reached with the finger.

Ano-rectal Imperforation: that is the first point settled. Is the defect limited to the anal canal, or to the lower rectal segment, or does it extend up to the sigmoid colon? Place the tip of the finger on the rudimentary anus, or introduce it to the bottom of the cul-de-sac and try to discover if any projection or bulging can be felt when the child strains or cries. The sensation is only of value if it is quite definite, in which case one has to do with a very simple malformation; the blind end of the gut is close to the surface, and the necessary operation will be very easy.

If, on the other hand, nothing can be felt, then one has no means of knowing at what height the rectal ampulla is situated (*Fig.* 88), and it is possible that a very considerable length of the bowel may be impermeable: this becomes probable when the perineum is narrowed, the ischial tuberosities and rami are placed unduly close together, and the outlet of the pelvis is evidently in a condition of arrested development. An examination of the abdomen in the rare cases where everything is not masked by the distention may furnish some useful information; in one of the iliac fossæ, left or right, a distended, dull, thickened coil of bowel, often of enormous size, may be perceived; whether or not it descends into the pelvis, it is impossible to say.

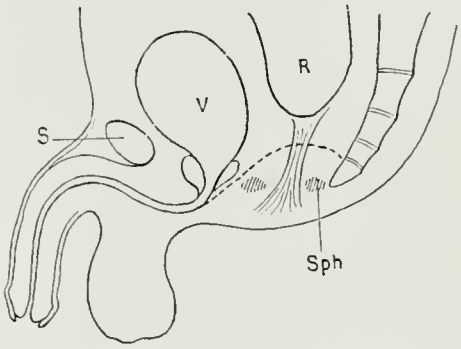

Fig. 88.—Ano-rectal imperforation (3rd type). A variable length of the lower portion of the rectum is absent. (S) Symphysis. (V) Bladder. (R) Rectum. (Sph) Anal sphincter.

Therefore, excluding the simple cases of which I have already spoken, we have no definite factors from which to draw conclusions, and must needs seek for the occluded end of the bowel.

The line of action is perfectly clear: **the terminal ampulla must be sought for by way of the perineum, and if found must be attached to the skin so as to provide an ano-rectal canal lined with mucous membrane**; the abdominal route is only to be adopted as a last resort after serious efforts to reach the rectum by the perineal route have failed.

Never make an exploratory puncture; if the rectal ampulla is situated near the surface of the perineum, opening it with a trocar is never so good as an incision followed by careful muco-cutaneous suture; if the ampulla is high up, then the trocar is a blind and dangerous exploratory instrument.

Make the necessary preparations for performing the only rational operation, one that is often difficult undoubtedly, but which after all, with some determination, is possible in the great majority of cases; the whole after-life of the little patient will depend on your success.

The child is well wrapped up, and placed on a firm pillow, with the thighs separated and flexed on to the abdomen and the pelvis elevated. Chloroform is not absolutely necessary, and may be dispensed with if the general condition seems too doubtful. The bladder is emptied with a catheter, which is left in place; the field of operation is freely washed with soap and water, and prepared in the usual manner.

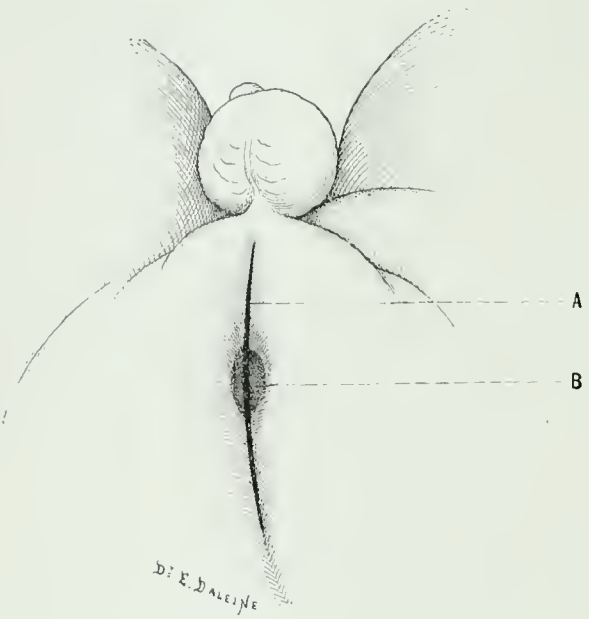

Fig. 80.—Operation for imperforate anus. 1st step: Median perineal incision. (A) Line of the incision. (B) Anal depression.

If the closed anus is bulging and the septum is very thin, the operation is exceedingly simple: the membrane has sometimes been ruptured with the finger; but such a rough measure is seldom possible, and never to be recommended; nor should puncture with a trocar be performed; the best plan always is to make a regular incision, antero-posterior or crucial, and to unite the skin and mucous membrane by a few points of suture.

In ordinary cases **where it is necessary to look for the rectum without any definite guides,** the procedure will be as follows:—

Make a median antero-posterior perineal incision, beginning in front immediately behind the fourchette or at the root of the scrotum, and extending posteriorly beyond the tip of the coccyx: *make sure that the incision is absolutely median, and keep carefully to the median plane during the course of the subsequent dissection* (*Fig.* 80). The anal depression and the membrane which forms the bottom of it will be cut in two by the incision, and the two lateral flaps dissected up and retracted to either side, *care being exercised to avoid any unnecessary damage to the muscular fibres underlying the skin.*

One is now in the midst of a layer of fibro-fatty tissue, the finely

lobulated and dense fatty tissue of the new-born infant. *Do not spend time in looking for the fibrous cord which is supposed to represent the imperforate segment of the rectum.* and which it has been said may serve as a guide; perhaps it may be met with by the way; but waste no time in looking for it, and if by chance it is discovered, if it appears to lead in a forward direction, do not rely on it.

As a matter of fact, *the danger lies in front*; there, the urethra, the bladder, often very large and adherent to the rectum, the vagina, and the peritoneal reflection, are situated; it may possibly be necessary to open the peritoneum, but it is always preferable to respect it if possible.

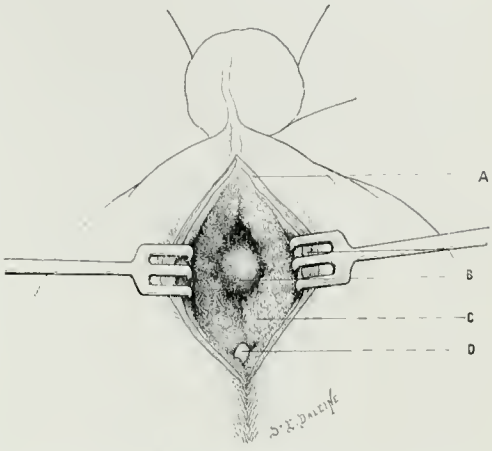

Fig. 90.—Operation for imperforate anus. 2nd step: Exposure of the rectal ampulla. (A) Edges of the incision, retracted. (B) Ampulla. (C) Perirectal fat. (D) Tip of the coccyx.

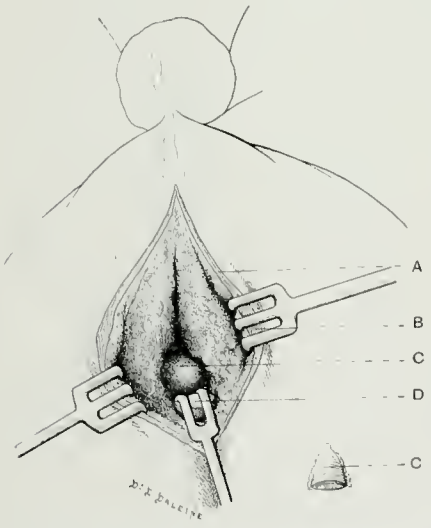

Fig. 91.—Operation for imperforate anus. 2nd step: Exposure of the rectal ampulla after excision of the coccyx. (A) Edge of the skin incision. (B) Margin of the wound retracted. (C) Ampulla. (D) Coccyx partially resected and retracted backwards. (C′) Excised portion of the coccyx.

Continue the dissection, with the point of the knife making shallow cuts from before backwards, but chiefly with the finger and the director; take advantage of the full length of the superficial incision, and endeavour to open up a trench, not a pit; but work mostly in the posterior part of the area, in front of the coccyx and sacrum, where there is nothing to fear.

But if it is necessary to penetrate to any depth, or if the pelvis is unusually narrow, the work will soon be hampered by want of room. Do not hesitate to adopt the very old plan recommended by Verneuil of excising the lower half or two-thirds of the coccyx. Its white, cartilaginous tip will be seen in the posterior angle of the wound (D, *Fig.* 90): free its borders and divide it transversely with the scissors or the knife (*Fig.* 91): it is

surprising how much easier the approach to the deeper tissues is rendered by the excision of even a short segment.

At a variable depth, two, two and a half, three inches perhaps, the blind end of the gut appears (*Fig.* 91): at the bottom of the wound a blackish patch will be seen, and the finger will feel a tense rounded surface which becomes larger and bulges when the child cries or when pressure is applied to the abdomen; these characteristics are, however, not invariable, and the ampulla may sometimes present itself in a half-empty, flaccid, and notably less evident condition.

In such circumstances it will be well to proceed cautiously, and to make sure of the nature of the structure by further investigation in the posterior part of the area, before opening it.

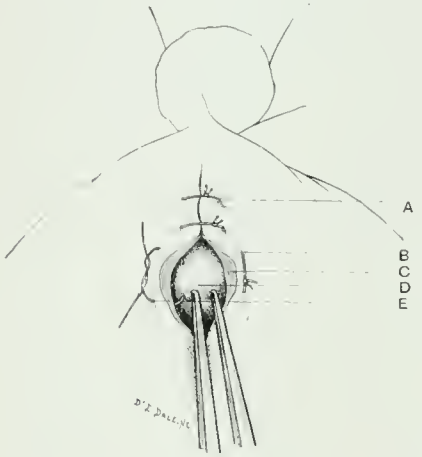

Fig. 92.—Operation for imperforate anus. 3rd step: Bringing down and fixing the ampulla. (A) Anterior part of the incision. (B) Lateral suture, tied. (C) Skin edges. (D) Ampulla. (E) Lateral suture, showing manner of execution.

Once the rectal ampulla has been found, the first step of the operation is completed; it only then remains to bring the blind end of the gut down as far as possible, to incise it, and to fix it to the skin, so forming the anus.

Devote all possible care to avoid rupturing the ampulla too soon; seize it with two pressure-forceps and continue the work of separation all around the gut, at the same time exercising gentle traction on the forceps (*Fig.* 92). The wall is often very thin, and tears under the slightest strain; the accident, however, as we shall see in a moment, is not serious if the peritoneum has been adequately protected.

If much difficulty is experienced in bringing down the end of the bowel, remember that it is not absolutely essential that it should be attached to the skin surface in the normal position of the anus; an anus placed somewhat behind the natural site will act equally well; but one must naturally beware of going too far in that direction, and forming an incontinent outlet behind the sphincter.

In the great majority of cases (M. Kirmisson has emphasized this point strongly)[1] there exists in the perineum a complete sphincter apparatus (*see Figs.* 86, 87, and 88), ready to take up its proper function if the lower end of the gut is fixed in the proper position.

[1] Kirmisson, "Imperforation ano-rectale traitée par l'anus iliaque: rétablissement de l'anus normal; suppression de l'anus iliaque; guérison." *Soc. de chir.*, 2 janvier, 1899.

The liberation and bringing down of the rectum is a step of the greatest importance, and directly the end of the gut has been found and the immediate success of the operation been thereby assured, it is always advisable to endeavour to perfect the work, even at the expense of prolonging the operation a little.

Liberate the rectum with the finger or the director, behind first of all, then in front: deal gently with the vessels; do not cut the bands and tracts of tissue which appear to prevent the bowel from coming down readily; the bands are *the vascular tracts*, and division would entail serious bleeding and probably cause gangrene of the bowel owing to loss of its blood-supply. It is blunt and gentle separation that is required.

If the gut cannot be freed sufficiently, do not hesitate to continue the separation in front up to the peritoneal reflection, and to open the latter freely; the anterior wall of the bowel will then be felt to yield at once, and to come down; the risk of tearing and other similar complications, which are so serious and occur so easily when operating in a very confined space, will thus be avoided. The opening in the serous membrane will be closed by a few interrupted sutures as soon as the gut has been brought down sufficiently; this opening of the peritoneum, which formerly was considered a serious operative complication to be avoided at all costs, may to-day be recommended as a most useful measure, with the reservation, however, that the opening is plugged temporarily with gauze to prevent any possible escape of meconium into the peritoneal cavity.

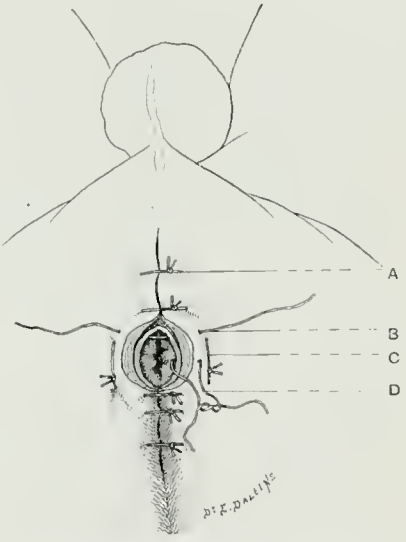

Fig. 93.—Operation for imperforate anus. 4th step: Muco-cutaneous suture. (A) Anterior part of the incision. (B) Anterior commissural suture. (C) Lateral sutures. (D) Muco-cutaneous suture.

Presuming that the ampulla has been drawn down to the perineum without rupturing, it should be fixed in position before being opened.

Introduce two sutures, one on either side (B *and* E, *Fig.* 92), picking up only the outer coat of the bowel, and of which both ends are passed through the corresponding lip of the perineal wound and are knotted on the skin parallel to the edge of the incision; in front and behind two other sutures are placed (B, *Fig.* 93); these four sutures hold the outer surface of the ampulla in contact with the raw edges of the incision in the perineal tissues. Close the rest of the wound in front and behind with a few deep sutures; if the dissection has been very extensive, it will be well

first of all to bring the fibro-fatty layer together by means of a continuous suture of fine catgut before suturing the skin.

Just as in forming an artificial anus on the abdominal wall, the bowel should only be opened after the suturing is completed; a stream of meconium escapes, and continues to flow sometimes for a considerable time; hasten the evacuation by gentle pressure on the abdomen, and then irrigate the area with warm boiled water.

The two flaps of mucous membrane now hang free at the perineum; spread them out right and left so that they overlap the margins of the orifice "like the brim of a hat" (Vincent, of Lyons), and suture them to the skin (*Fig. 93*); if necessary a strip of skin may be excised all around the orifice, to permit of more complete eversion of the mucosa and complete covering of the margin of the opening; in this manner the line of union is placed outside the external sphincter, and the dangers of retraction and subsequent stenosis are absolutely eliminated.

Use catgut for all the sutures: good catgut which will resist absorption for a sufficient length of time; by so doing, the necessity for any after-interference will be obviated.

All the dressing that is required is a piece of sterile gauze, some wool, and a T-bandage; it must however be frequently changed. Minute attention to cleanliness is essential if rapid healing is to be obtained.

Under the conditions just detailed, operation, though not easy, is at least perfectly straightforward. One must not, however, expect that will always be so.

(*A*). And first, it is often far from easy to bring the blind end of the bowel down to the perineum without rupture; during the attempts at separation the wall may give way under the finger or the director, or may be torn by the forceps.

Again, the terminal ampulla may be so distended, and so far fill the pelvis that it may be practically impossible to get past it to effect the necessary separation: under such circumstances the best plan is to open the bowel freely and empty it; then, after closing the incision by means of two pairs of forceps, and irrigating the wound with boiled water, to proceed to separate and bring down the flaccid organ.

The same treatment is applicable in case of accidental rupture; if the bowel-contents escape into the wound, let them run; irrigate the area freely with boiled water, have the two sides of the wound well retracted and, once adequate cleansing has been effected, look for the opening in the ampulla, secure the edges with forceps, and then proceed with the separation as before.

Only as a measure of necessity, and after the failure of well-ordered and persistent attempts, will it be justifiable to abandon the efforts to bring the rectum down to the skin, and so to leave the raw perineal canal without a mucous lining. In fact it would only be in conditions of extreme urgency, at the end of a long operation, when the rectum was

situated at an unusually high level, and when the difficulties in the way of bringing it down were quite exceptional, that one would be justified in terminating the operation in the quickest possible manner, that is, by leaving a large drainage tube in the channel between the bowel and the perineum. Often it would even be preferable to attach the opening in the bowel to the skin surface quite far back, so making a "coccygeal anus."

(*B*). Another possibility may arise which is even more disconcerting. After having worked inwards for a considerable distance, **nothing that resembles the rectal ampulla can either be seen or felt.**

Must the attempt to create an opening in the natural position be abandoned, and is it possible to lay down a definite distance-limit beyond which any exploration becomes useless and dangerous? We do not think so. When we remember that the rectum has been found at a depth of over three inches, and that *a perineal anus is of vital importance to the child*, we must recognize the necessity of pursuing the search with determination. Still one must also know when to stop, since a dissection continued blindly at the bottom of the wound, when nothing can be seen and nothing definitely felt, involves the risk of most serious injuries.

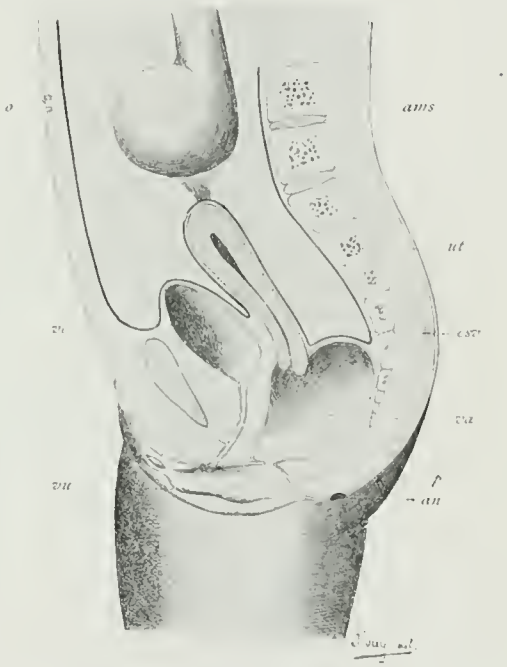

Fig. 94. Total absence of the rectum; sigmoid ampulla. (CHALOT: *Bull. de la Soc. de chirurgie*, 1896, *loc. cit.*) (*p*) Perineum. (*an*) Rudimentary anus. (*va*) Vagina. (*ut*) Uterus. (*ve*) Bladder. (*ams*) Sigmoid ampulla, so placed for purposes of demonstration, but in reality inaccessible to sight and touch from below. (*vu*) Vulva. (*csv*) Sacro-vaginal reflection of the peritoneum. (*o*) Umbilicus.

What is to be done then? **Make an artificial anus in the iliac region?** Yes, certainly, if the child appears to be dying, or incapable of bearing any prolongation of the operation. At the same time, however, we must remember the remarkable way in which new-born children bear operation so long as they do not lose blood.

Therefore, if the perineal exploration has been comparatively short and properly carried out, if the infant's general state appears to be still satisfactory, take the bolder plan **of opening the abdomen in the left iliac fossa, and by that route endeavour to liberate the terminal ampulla sufficiently to allow it to be brought down to the perineum.**

As a matter of fact, in the cases of this kind the condition, strictly speaking, is one of *complete absence of the rectum*, and as Delagenière[1] has shown, the large intestine ends opposite the left sacro-iliac synchondrosis, " below and internal to which it extends for about half an inch or an inch " ; further, the extremity is usually attached to the posterior wall of the true pelvis by a vascular pedicle of variable length and laxity.

Chalot,[2] in a case on which he operated, discovered without difficulty, in the left iliac fossa, at the inner border of the psoas muscle and behind the left appendages, " a soft, fluctuating, reddish-coloured terminal swelling, about 4 inches in length and pear-shaped ; the larger extremity, which

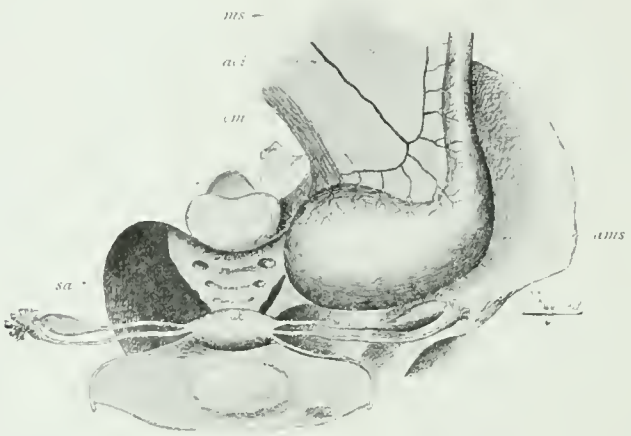

Fig. 95.—Total absence of the rectum ; sigmoid ampulla. (CHALOT, *loc. cit.*) (*ams*) Sigmoid ampulla. (*ut*) Uterus and appendages. (*sa*) Sacrum. (*aci*) Inferior colic artery. (*cm*) Meso-colic band. (*ms*) Meso-sigmoid.

was mobile and perfectly smooth, and of the size of a large hen's egg, was directed downwards and forwards towards the uterine end of the left tube, while the other extremity, marked on its anterior surface with a longitudinal muscular band, and directed upwards and backwards, tapered gradually to the diameter of the descending colon, with which it was directly continuous. The ampulla was curved on itself, and floated free, except for the attachment of a small, fan-shaped, but perfect mesentery ; the mesentery did not, however, extend to the rounded extremity, which would have been entirely free but for a vasculo-cellular band which attached it to the side of the uterus below and behind the left tube " (*Figs.* 94 and 95).

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[1] P. DELAGENIÈRE, " Absence congénitale du rectum, nouveau procédé d'intervention." *Congrès de chir.*, 1893, and *Arch. prov. de chir.*, juillet, 1894.

[2] CHALOT, " La colostomie ou sigmoïdostomie périnéale par la voie combinée dans l'absence congénitale du rectum. Succès." *Bulletin de la Société de chirurgie*, 15 avril, 1896, p. 318.

In general terms, the abdomen will be opened by a left iliac incision, the intestinal ampulla sought for and brought down, after section of any retaining bands, across Douglas' pouch to the perineum.

Make an oblique incision half an inch to the inner side of the antero-superior iliac spine (*Fig.* 96), similar to the ordinary colostomy incision, but commencing lower down (at the pubic spine) and extending upwards to the level of the umbilicus; free access is necessary if the intra-abdominal manipulations are to be carried out simply and quickly.

As soon as the peritoneum is opened, the presenting small intestines are pushed up out of the way and covered with a sterile compress (the inclined position is very useful during this step), and usually the terminal ampulla is found without any difficulty; "its distention, its longitudinal bands, and its continuity with the rest of the colon" indicate it sufficiently. Its degree of mobility will be determined, and if it is attached to the sacral promontory or to the neighbourhood of the pelvic brim or to the uterus, the retaining bands will be carefully divided between ligatures.

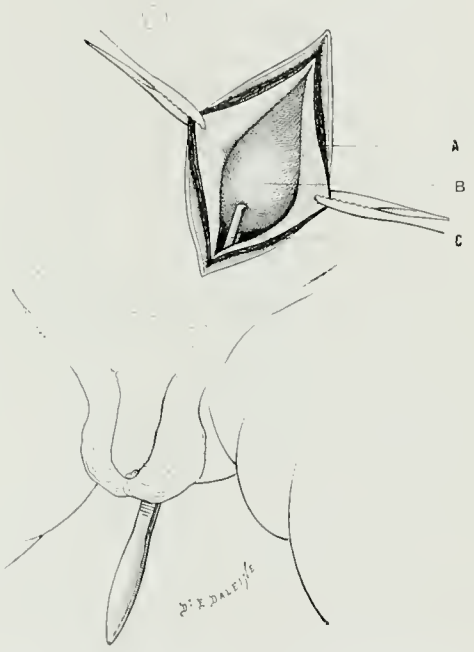


Fig. 96.—Congenital absence of the rectum. Abdomen opened by iliac incision; bringing down the ampulla. (A) Peritoneum. (B) Sigmoid ampulla. (C) Forceps passed up from the perineum, drawing down the ampulla.

The next step is to make sure that the bowel is sufficiently free to allow its extremity to descend $2\frac{1}{2}$ or 3 inches at least (that is the average distance from the sacral promontory to the tip of the coccyx, according to Chalot).

If the dilated end is too large to enter into the cavity of the true pelvis, which is always rather small in the patients with these congenital defects, it must, following Chalot's example, be drawn out through the parietal wound and, having been carefully surrounded with aseptic compresses emptied through a short incision. As soon as the evacuation is complete, the incision will be closed with a few sutures or by forceps.

The right index finger is then introduced through the iliac wound, and slipped from above downwards along the anterior surface of the sacrum to the bottom of Douglas' pouch, while the left index finger is passed into

the perineal wound which had been made in the first stage of the operation ; it is then usually very easy to rupture the thin layer of tissue which still separates the perineum from the abdominal cavity ; the " pelvic " finger usually suffices to break through, or, if necessary, a director or the closed end of a pair of pressure-forceps will make the opening without trouble.

It only now remains to introduce a long curved forceps from below upwards by way of the perineum, to seize the extremity of the ampulla (C, *Fig.* 96) and to draw it down ; the same object may also be attained by means of a thread passed through the wall of the ampulla and seized with the forceps. In some cases it may be easier to push down the ampulla from above with forceps into the lower wound, where it may be secured.

Chalot in his case had been compelled to open and empty the gut ; he closed the small opening with a strong silk ligature, and used the two ends to guide the intestine into the perineal channel. The two ends were threaded into the eye of an aneurysm needle ; " the needle was passed down along the anterior surface of the sacrum, through the opening in the bottom of Douglas' pouch, then into the perineal wound, where it was guided in front of the coccyx by the left index finger passed up from below." The two ends of the thread were seized and drawn out, and in their turn served to pull the end of the gut down to the perineum.

As soon as this step is completed, the abdominal wound will be closed. Then the bowel will be fixed to the margins of the perineal incision, opened, emptied, and the muco-cutaneous sutures carefully introduced in the manner already described.

This method has given successful results in Chalot's hands ; Delagenière's patient died on the ninth day, of bronchopneumonia.

It is therefore worthy of a trial, and by means of it the indications for an artificial anus are still further restricted. If, when the abdomen is opened, an abnormally situated and fixed ampulla is discovered, then naturally it will simply be attached to and opened on the abdominal wall.

An artificial anus in the iliac region is, and ought to be, nothing more than a last resource, applicable only to those exceptional cases in which the whole of the rectum and part of the sigmoid colon are absent, or in the almost desperate cases in which the patient's general condition permits of nothing but the simplest and most rapid procedure.

The gravity of an artificial anus depends partly on the immediate bad results which it too often gives, as the mortality is considerable, and secondarily on the precarious condition of the children who survive the operation. The number of those who develop and live for even a few years is very small. Two patients who lived to the age of 43 years have been quoted as curiosities, as also a girl on whom Ollier had operated, who could meet all the demands of modern life, and " was about to be married."

These are fortunate and very rare anomalies ; that is all that can be said about them ; if the operator fully recognizes that the whole future of the little being whom he has under his hands depends on his action, he will use his utmost endeavours to avoid producing such an infirmity.

If an iliac anus cannot be avoided, it is important that it should possess those characters which will ensure its satisfactory action, and its subsequent easy closure if desirable.[1]

A segment of the anterior wall of the sigmoid colon (not the whole loop) is drawn up into the exploratory incision, the extremities of the wound are then closed, and the segment of the anterior wall of the sigmoid is united at once to the abdominal wall by a circle of interrupted sero-muscular sutures ; a small opening, not more than half an inch long, is made into the bowel, and the mucous membrane attached to the skin by sutures of fine catgut.

It is quite unnecessary to make a large opening in the intestinal wall ; fæcal drainage is quite as well assured by an orifice of moderate dimensions, and late complications, such as eversion of the mucous membrane, prolapse of the bowel, etc., are more easily prevented, and closure of the fistula will be a much more simple matter, should it ever become desirable : in other words, if the child should survive, and if, by a subsequent operation, it should be possible to find the rectal ampulla and to bring it down to the perineum.

It is always advisable to have recourse to secondary perineal exploration at the earliest possible date, taking advantage of the iliac opening to pass a bougie into the lower end of the bowel, to serve as a guide.

Secondary "proctoplasty" has given very satisfactory results in the cases recorded by Lannelongue,[2] Anders,[3] and Kirmisson ;[4] in the last of these, the patient was a child ten days old, on whom an iliac anus had been made on the fourth day after birth, after an unsuccessful perineal exploration ; the infant was in "a very precarious condition, emaciated, and with pinched face." There was a large intestinal prolapse, about

[1] This is by no means always the case. In a young girl whose history we have reported elsewhere, the fæcal fistula was not permanently closed until the age of 14 years, notwithstanding repeated attempts.

She was born with an imperforate anus, and two days later an artificial anus was made in the left iliac region. Two years later M. Péan sought for the rectal ampulla by the perineum, found and opened it, and provided a natural anus. On three subsequent occasions he tried to close the fistula which still persisted in the iliac region, but failed. Other operations performed during the following years were equally unsuccessful. The fistula, however, seemed to have been reduced to comparatively small dimensions, and was scarcely larger than a sixpenny piece, not at all prominent, surrounded by a reddish-coloured margin, and occupying the centre of a zone of cicatricial tissue : but fæcal matter always escaped from it.

In 1897, the girl being then 14 years of age, I tried to close the fistula by dissecting up the margin, and after having invaginated it by suturing in layers what appeared to me to be the different planes of the abdominal wall. All the sutures cut out, and I then perceived that underneath the abdominal wall and the orifice which I had closed, there was a large cavity, at the bottom of which the real intestinal orifice was situated.

In a second operation I excised and curetted the wall of the adventitious sub-parietal pouch : I opened the peritoneum and drew out the whole of the segment of the sigmoid which bore the very extensive deficiency. I closed the opening by lateral enterorrhaphy, and over it sutured the abdominal wall in layers

This time a successful result was obtained, and my little patient was at last freed from her infirmity and is now in excellent health. (*Soc. de chir.*, 21 déc., 1898).

[2] LANNELONGUE, *Bull. de la Soc. de chir.*, 1884, p. 200.

[3] ANDERS, "Ueber das operative Verfahren bei congenitaler, analer und rectaler Atresie, sowie Ausmündungen des Rectum in das Urogenitalsystem," *Arch. f. klin. Chir.*, 1893, Bd. xlv., p. 489.

[4] KIRMISSON, *loc. cit.*

4 inches in length, from the artificial anus. Owing to the crying and straining of the child during the attempts at reduction, the wound burst open, and a large mass of intestines was protruded. Immediate action was therefore necessary. After the protruding coils of intestines had been replaced in the abdomen, a bougie was passed into the opening in the sigmoid colon, pushed as far downwards as possible, and could be felt in the perineal wound. It was therefore a comparatively simple matter to pass sutures through the wall of the rectal ampulla, to draw it down to the perineum, to open it, and suture it in position. The artificial anus was closed at a second operation, and the child made a perfect recovery. This interesting case provides an excellent demonstration of the resisting powers of these very young children.

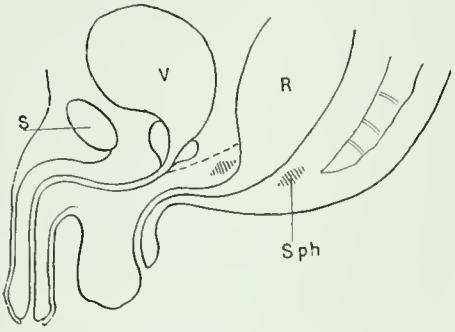


Fig. 97.—Abnormal opening of the rectum at the posterior part of the scrotum.

Abnormal Openings of the Rectum.—What has just been said applies to ano-rectal imperforations properly so-called. Abnormal openings of the rectum give rise much less frequently to urgent indications. If the opening is of fair size, and in the neighbourhood of the perineum, at the root of the scrotum (*Fig.* 97), at the fourchette, or in the lower part of the vagina, adequate escape of the intestinal contents is assured, and under quite endurable conditions if due attention is given to the necessary cleanliness. The best plan, then, is to wait until the child is old and strong enough to allow the necessary operation to be carried out in one stage without undue risk.

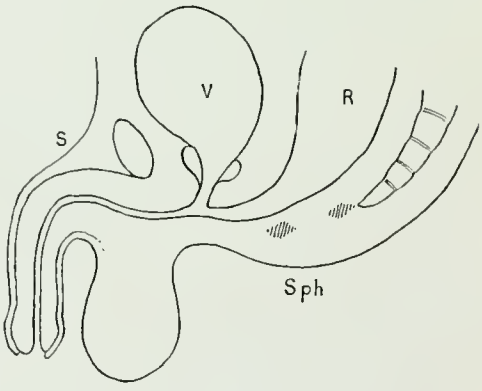


Fig. 98.—Abnormal opening of the rectum into the deep urethra.

The problem presents itself in somewhat different terms: (*a*) **When the intestine opens into the urinary tract** (*Fig.* 98); (*b*) **When the abnormal opening or channel is too narrow to provide a free escape for the intestinal contents** (*Fig.* 99), and symptoms of fæcal retention arise.

In either case the rectum must be sought by way of the perineum, and opened as soon as possible ; on the one hand, the operation will cause the disappearance of the symptoms of fæcal absorption, and on the other, by providing a free way of escape for the intestinal contents, it will tend to bring about a spontaneous obliteration, or at least progressive contraction, of the abnormal openings and channels.

It is, of course, impossible to depend on the complete spontaneous closure of the ectopic channel, and very often some operative measures will be required at a later date to complete the restoration to normal conditions. This point is demonstrated by numerous cases, and particularly by the comparative frequency of recto-urethral fistulæ.

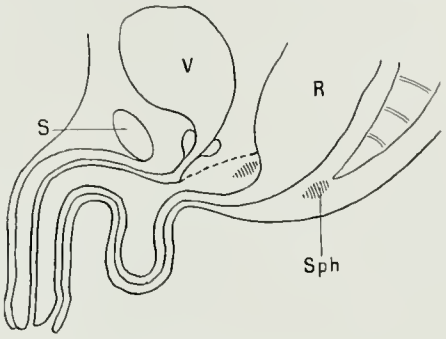


Fig. 99.—Abnormal opening of the rectum at the extremity of the penis.

In the case of a boy five years of age on whom I operated[1] for a fistula of this kind, the history, which may be taken as typical, was as follows :—

The boy was born with an imperforation of the anus, and had been operated on the day after birth at the Enfants-Malades Hospital ; the result of the operation was excellent, the anus being quite normal in appearance and function. But urine escaped by the rectum in variable but always considerable amount ; and further, the urine passed by the urethra was from time to time mixed with fæcal material. As a matter of fact there was a recto-urethral communication $\frac{1}{3}$ inch in diameter situated at about $\frac{1}{2}$ inch from the anus.

In the case of a vigorous child with an easily accessible fistula, instead of simply opening the rectal ampulla and suturing its margins to the perineum, it is undoubtedly possible to expose the anterior wall of the rectum by dissection, to divide the channel of communication, and to suture the two resulting orifices, at the same time taking care to pull down the rectal wall, so that the two sutured openings no longer remain opposite each other.

But such an operation is always a serious one on a new-born child, especially in the condition in which these little patients are usually found at the time when operation is undertaken ; as a rule it is wiser simply to find the ampulla and open it. In this group of malformations, where there is a recto-urethral or recto-vaginal communication, the terminal end of the rectum is often dilated below the level of the abnormal channel, and is not usually difficult to find. It has sometimes been possible to introduce

[1] "La cure opératoire des fistules recto-urétrales," *Soc. de chir.*, 18 juillet, 1894, and *Leçons de chirurgie de la Pitié*, 1893-1894.

a probe or sound into the bowel through the urethral or vaginal orifice and, by inclining the instrument towards the perineum, to indicate the position of the ampulla. In a case recorded by Duret,[1] a probe, introduced by the urethra, directed itself naturally towards the hollow of the sacrum, and on tilting up its external extremity, the probe-pointed end could be felt in the anterior part of the perineal wound. It was only separated from a finger introduced into the wound by a partition about an eighth of an inch in thickness. An incision was made through the septum, and gave issue to a stream of meconium.

Lastly, mention must be made of those exceptional malformations,[2] in which any attempt at repair is out of the question, and which leave the patient with but slender chances of survival; I refer to those wide communications between the intestine, cloacæ, etc., cases which belong to the group of curious anomalies, but which are of no practical importance to the surgeon. I must also mention the stenoses and septa which are sometimes discovered post mortem, situated high up in the intestine, and which of course render any perineal or iliac operation perfectly useless.

I must, however, repeat that these cases are quite exceptional, and **that ano-rectal imperforation, in its common form, is curable, if it is recognized in time and properly treated.**

WOUNDS, PERFORATIONS, AND RUPTURES OF THE RECTUM.

These are uncommon accidents: we shall simply describe the principal clinical types and discuss the necessary treatment from a general standpoint. We must study separately: (1) *The injuries of the extraperitoneal portion* of the rectum; (2) *The injuries of the intraperitoneal portion*, in other words the wounds and perforations which open into the peritoneal cavity; (3) *The traumatic lacerations and spontaneous ruptures complicated by hernia of the intestine.*

1. **Injuries of the Extraperitoneal portion of the Rectum.**—Every traumatic lesion of the rectum must be considered as serious, the gravity depending partly on the risk of *hæmorrhage* (primary or secondary); partly on the possibility of *infection* and *fæcal infiltration* of the perirectal planes of cellular tissue, the ischiorectal fossæ, etc. One general rule must be laid down first of all: an adequate exposure is essential; free access must be provided by one or other of the various methods of anal dilatation, or even by open incision, so that the seat and characters of the wound may be accurately determined; hæmostasis must be effected

[1] Duret, "Sur un cas d'abouchement anormal du rectum dans l'urètre: opération d'Amussat: guérison." *Comptes rendus du Congrès de chirurgie*, 1885, p. 628.

[2] Rudolf Frank, *loc. cit.*

if necessary, and above all, disinfection and drainage of the rectum must be insured. The last-mentioned point is of capital importance, because the rectum, transformed into a species of closed vessel by a contracted sphincter, speedily becomes a laboratory for the production of septic materials.

Let us assume that a man, by a fall, has been impaled on a pointed rod; he is found pale and exhausted; he has lost a considerable quantity of blood, and the hæmorrhage still continues from the anus. There are no abdominal reactions; the accident has just occurred, or at the most only a few hours previously.

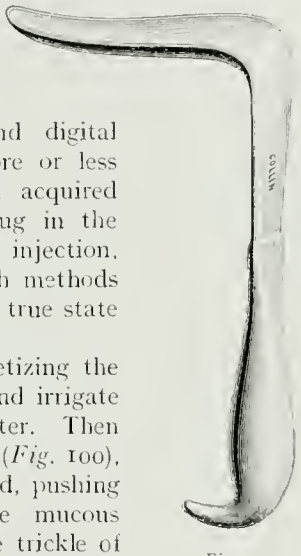


Fig. 100.
Rectal retractor.

Never rest content with making a blind digital examination of the rectum, and with some more or less vague ideas as to the nature of the wound acquired thereby; nor with simply leaving a gauze plug in the cavity if, after the administration of a warm injection, the bleeding seems to have been arrested. Such methods are quite inadequate for the recognition of the true state of affairs, or for the treatment of the injury.

Begin, if the conditions permit, by anæsthetizing the patient; dilate the anal sphincter thoroughly, and irrigate the rectal cavity freely with warm boiled water. Then depress the posterior wall with a long retractor (*Fig.* 100), raise the anterior wall in a similar manner, and, pushing the two retractors slowly inward, cleanse the mucous surface with swabs in holders, and follow up the trickle of blood which comes from the depths.

In this way the focus of injury will gradually be reached; if it is situated high up and tends to slip away from view, seize the upper margin of the wound with Kocher's forceps or fine-toothed dissecting forceps, taking care, however, to exercise only moderate traction. Irrigate the whole region again with warm boiled water, and then, raising the edges with the forceps or the finger, determine the depth of the wound.

If the blood continues to flow freely, perhaps in jets, cleanse the bottom of the wound with small swabs, search for the bleeding points, and secure them with long pressure-forceps, which may be left in position. If the wound is at all high up, it is exceedingly difficult to apply a ligature to a bleeding point: fairly often, however, some **mass sutures** grasping and approximating the whole thickness of the two edges of the wound, at least in the bleeding area, may be substituted for the ligatures, and may also be used instead of leaving forceps in place, which is never anything better than a makeshift procedure in a mucus-lined cavity.

If the bleeding is nothing more than a *diffuse oozing* from a contused and lacerated wound, the best plan is *to pack the wound* with a strip of

aseptic gauze and also to pack the rectum at the level of and below the wound; *a large rubber drainage tube* must always be left in the centre of the gauze, its upper end extending above the level of the packing and the lower emerging from the anus. If properly placed, the tube will not interfere with the effect of the packing, and it will render the intrarectal dressing supportable, by providing a channel for the escape of flatus.

Endorectal suture is permissible only in the case of recent, clean-cut wounds, which are not very deep and are quite dry, particularly as the sutures may readily transmit infection from the mucous surface into or even to the outer side of the rectal wall, and may become the starting-points for secondary septic complications. It is therefore important to have the rectum freely irrigated several times daily, and to keep the bowels from acting, for a sufficient length of time.

Sometimes it is possible to close the wound from without: I refer to those cases in which the wounding body, having entered by the anus, perforates the wall of the bowel and emerges on the skin surface, at the root of the scrotum, for instance, or at some other neighbouring point. In these circumstances, after having dilated the anal sphincter and carefully examined and cleansed the intrarectal wound, the correct treatment will be to enlarge the superficial wound, open up the track freely, and repair the rectal perforation from the outside by means of a sufficient number of interrupted sutures, excluding the mucous membrane, and finally to suture the superficial wound, with or without drainage as may be necessary.

Lastly, those very extensive rectal lacerations produced by impalement[1] with very large objects or as a result of gunshot wounds, require mention; in these cases the fundamental rule laid down above finds its strictest application: **a free way of access must be provided for purposes of cleansing, packing, and drainage.**

Stiassny has published an exhaustive monograph on wounds by impalement, of which he has collected 127 cases.[1] The impaling object may enter not only by the anus but also by the vagina, the perineum, the ischio-rectal fossæ, or the coccygeal region, and the lesions may be divided into two principal groups, according as they are limited to the extra-peritoneal zone or, having penetrated the peritoneum, they affect the pelvic organs at a higher level. In the first group it is very seldom that any attempt at immediate repair should be made; the treatment should be limited to the control of bleeding and the provision of drainage; in the second group, immediate abdominal section is indicated for the purpose of finding and suturing any perforations which may exist. (*See* WOUNDS AND RUPTURES OF THE BLADDER, RUPTURES OF THE URETHRA, etc.).

Gunshot wounds are of peculiar gravity, which is accentuated by the frequency of lesions of neighbouring organs, and particularly of injuries of the pelvic bones. Intraperitoneal penetration, however, appears to be a comparatively rare complication of gunshot wounds of the rectum;

[1] "Ueber Pfählungsverletzungen," *Beiträge zur klin. Chirurgie*, Bd. xxviii. 2, p. 351.

out of 59 cases which terminated fatally, in one only had the bullet affected the peritoneum-covered portion of the bowel.

Simple anal dilatation is insufficient; **the sphincter and posterior rectal wall must be incised** as high as may be necessary to provide adequate access in the precoccygeal region.

The section of the bowel is made most simply with the thermo-cautery, and the best line of action is the following: *a transverse incision* is made with the scalpel, just in front of the tip of the coccyx, opening into the recto-coccygeal space, into which a large grooved director is introduced: *the tip of the director is pushed through the posterior wall of the rectum* at a sufficient height above the anus, and a large flat retractor is introduced through the anus, to raise and protect the anterior rectal wall. Then the posterior ano-rectal wall is divided on the director, layer by layer, with the thermo-cautery at a dull-red heat.

When thus executed, the operation presents no real difficulty; it gives plenty of room, and if the after-treatment is carefully carried out, if the bowel is frequently and freely irrigated (with boiled water with the addition of some peroxide of hydrogen), healing often comes about in a most astonishing manner.

2. **Injuries of the Intraperitoneal portion of the Rectum.** — When a penetrating wound situated high up is found during the rectal exploration indicated above; or again, when commencing abdominal reactions, distention and tenderness raise suspicions of the existence of peritoneal perforation, although nothing definite has been detected by intrarectal examination, there can be, in our opinion, no question as to the correct line of treatment; the responsibility of delay in such circumstances is too grave to be accepted.[1]

I recognize that it is possible to drain the rectum, and sometimes even to introduce a tube or a strip of gauze into the perforation itself; that the peritoneal invasion may be of very limited extent,[2] and the infection may remain restricted to part of the pelvic cavity; all these possibilities are realized from time to time; but here again, expectant treatment is associated with very great risks, and most commonly the fear of immediate operation will entail disaster, after the lapse of a few days of deceptive well-being.

[1] See the article by M. Quénu ("Des plaies de la portion péritonéale du rectum et de leur traitement." *Revue de chirurgie*, 1899, No. 1).—The patient had been under treatment for syphilitic disease and stricture of the rectum. For the purpose of administering a douche, a dresser had introduced an elastic catheter fairly high up into the rectum, and had then injected a solution of hydrogen peroxide. The patient immediately felt an acute pain in the lower abdomen and vomited twice, but an hour later the general condition furnished no positive indication of a perforation. A little later, however, the face had become pinched, the abdomen sensitive and distended. Laparotomy was performed by M. Quénu six hours after the administration of the douche. The intestines were found bathed in serous fluid which was already becoming turbid; on the right side of the rectum, two inches above the bottom of Douglas' pouch, a small, very oblique perforation, partly hidden by a fringe of omentum and surrounded by an ecchymotic zone, was found. It was closed by a double row of sutures of fine silk. The pelvis was washed out with warm boiled water, and two large drainage tubes were left in the cavity. The patient recovered.

[2] The wounding instrument may possibly burrow in the wall of the rectum between the coats, without actually entering the peritoneal cavity.

I have witnessed a tragedy of this kind, which was the more striking in that the treatment of "armed expectancy" had been applied by one of its most eminent advocates.

Case 11.—The patient was a man some 30 years of age, who, on the evening of the 27th March, had introduced a piece of iron wire about 18 inches long and $\frac{1}{12}$ inch diameter into his rectum; about 10 inches of the wire appeared to have passed into the bowel. A sudden and very severe pain was felt at the moment of introduction: the patient was able to withdraw the wire himself, but the pain continued and was felt particularly in the left iliac fossa, and during the night extended over the whole of the abdomen; there was no hæmorrhage from the rectum, but there was retention of urine, and during the night the patient vomited thrice, the vomit consisting of greenish material. During the following day, the 28th, the general condition and symptoms remained much the same; there was some nausea, but no more vomiting. On the 29th the patient was admitted to hospital; he was dejected, with anxious face, pulse 112, the abdomen not much distended but generally tender; there was no vomiting; the bowels had not acted, nor had flatus been passed since the accident. Ice was applied to the abdomen, some morphia given, and injections of salt solution were administered. During the night there was more greenish vomiting; but on March 30th and 31st and April 1st there seemed to be a decided improvement, the abdominal tenderness diminished, the temperature became normal, although the pulse remained fast; during the night of the 1st of April the bowels moved spontaneously, the motion being soft, bloody, and associated with a deep-seated pain in the left iliac fossa. On April 2 the bowels acted twice.

From this time the situation slowly become worse, with occasional transitory improvements and without any violent symptoms; finally, on the 6th there could no longer be any doubt of the existence of diffuse acute peritonitis; the pulse was miserably poor, the tongue dry, the abdomen enormously distended: operation appeared to be absolutely useless, and the patient died during the day, that is, on the tenth day from the accident, after the bowels had acted repeatedly and after having passed through—from the third to the seventh day—a period of apparent improvement which had raised expectations of a successful result from "medical treatment."

At the autopsy the usual signs of diffuse peritonitis were found; there was a great quantity of sanious, purulent fluid, filling the pelvis, and diffused amongst the adherent coils of intestine and on the side of the rectum, a little below the level of the left sacro-iliac synchondrosis, *there was a perforation, the size of a sixpenny piece, with fissured and discoloured margins.* In my opinion all discussions and theories are worthless when compared with the teaching of such a case as this.

Further, the great danger associated with these perforating wounds of the intraperitoneal portion of the rectum is very well shown by Quénu's statistics: out of 36 cases, there were 27 deaths and only 9 recoveries.[1] Death usually supervenes with great rapidity, and the early fatal termination is an indication of the extreme virulence of the infection.

[1] Of the 36 cases, laparotomy was performed in 6, with 4 recoveries and 2 deaths: in 20 there was no operation 5 recoveries, 24 deaths. This gives a mortality of 33 per cent for the cases submitted to operation, 82 per cent for the others. As Quénu remarks, these figures are only of general application.

Therefore, if there are definite signs or symptoms sufficiently indicative of perforation—abdominal distention and tenderness, rapid pulse, facial appearance, vomiting—then **laparotomy must be performed as soon as possible,** with all the precautions already detailed for abdominal section in urgent conditions.

The patient will be placed in the inclined position, with the pelvis at first only moderately raised. The abdomen is incised in the middle line below the umbilicus, and after the intestines have been displaced upwards under a sterile compress, the pelvis will be carefully cleansed with dry swabs, and, as a rule, one will be guided by the effused fluids, the patches of purulent lymph, and the soft adhesions which so speedily form, to the site of the perforation, which is sometimes also indicated by an ecchymotic subperitoneal patch (Quénu).

There will sometimes be considerable difficulty in closing the rectal perforation when it is situated low down near the bottom of the pelvis :[1] when it is accessible, it will be closed after excision of its borders, *in two layers*, like any other intestinal wound, care being exercised to bring broad peritoneal surfaces in contact. Even when the perforation is situated low down, with patience, and by using a full-curved needle, the suturing can usually be satisfactorily executed, if the needle is entered at a sufficient distance from the edge on either side of the wound, and picks up a sufficient thickness of tissue.

Even when the accident is quite recent it will always be prudent to provide adequate pelvic drainage by means of one or two tubes enveloped with aseptic gauze.

The rectal perforation may be further complicated by the presence of other lesions, the most common of which is a perforation of the bladder ; it may even happen that the perforation of the rectum has been produced by way of the bladder.

3. **Traumatic Lacerations and Spontaneous Ruptures of the Rectum.**—I now come to the third group of cases, those in which **there is a large rectal perforation through which a loop of small intestine protrudes ;** they are uncommon, it is true, but are extremely serious and demand immediate action.

The spontaneous ruptures of the rectum may also be included in this group. They have been investigated by Quénu,[2] and the following case—the first observed by him—will form an excellent example. A man, 45 years of age, previously in good health, " was taken during the evening with a desire to go to stool ; during the efforts at defæcation, he felt an

[1] As for instance in a case of Lambotte's (Quénu, *loc. cit.*) : the patient had been impaled by an iron rod ; laparotomy was performed four hours after the accident. The peritoneum was full of bloody, serous fluid, and there was fæcal material in the pelvis ; the sigmoid colon had been perforated through and through ; on the free border, at about the middle of its length, there was a lacerated opening which admitted the index finger easily, and another perforation at the attached border. These two openings were closed. Another was found in the rectum, at the bottom of Douglas' pouch just behind the bladder, and was closed, after great difficulty, with three layers of sutures.

[2] Quénu, " Des ruptures spontanées du rectum." *Revue de chirurgie*, 1882, p. 173.

acute pain in the abdomen, and noticed that he was losing a considerable quantity of blood from the anus, and almost immediately afterwards a large loop of small intestine emerged from the anus, driven down by the abdominal contractions. The protruding intestinal coils formed a mass as large as an adult head, and measured approximately 6 feet in length."

What is to be done in such a case of sudden evisceration by way of the anus? The inclination to attempt immediate direct reduction is almost instinctive: it is, however, the worst line of treatment. Apart altogether from the fact that it is never completely successful—this has been repeatedly demonstrated—the restoration to the peritoneal cavity of intestines contaminated through prolonged contact with the rectal mucosa, and the adequate preliminary cleansing of which is always impossible, would, even if it succeeded, be followed by almost certainly fatal infection.

Laparotomy must be performed, and the prolapsed intestine reduced from within by traction, the details of the operation being varied according to the condition of the herniated intestines.

If the accident is of comparatively recent occurrence, and the prolapsed loop uninjured and in a healthy condition, begin by thoroughly irrigating the rectum and its contents with warm, boiled water, carrying the cannula as high up as possible, and guiding it with the finger over the whole surface of the intestine, in front and behind, and if possible up to the neck of the loop and to the rupture, which is usually situated on the anterior surface of the rectum. When this preliminary cleansing has been performed as thoroughly as possible, **open the abdomen by a median sub-umbilical incision,** with the patient in a moderately inclined position, and seek for the herniated loop where it is engaged in the perforation.

If the protruding intestine is tightly nipped, *enlarge the opening* in an upward direction in the middle line of the free border of the rectum; then draw the two limbs of the loop gently upwards, after having carefully surrounded the whole area with aseptic compresses, on which the intestine is received after reduction, and carefully examined and cleansed afresh. Once reduction is complete, if no suspicious area is discovered, proceed to close the rectal laceration by two rows of sutures and, for safety, leave a drainage tube in the pelvic cavity.

The situation is more difficult when the herniated intestine is shrivelled, flaccid, cold, partially gangrenous, or even already perforated.

To attempt to reduce into the abdomen a loop of intestine already perforated, or so friable that it would tear on the slightest traction, would involve serious danger of contaminating the intrapelvic operation area, notwithstanding the presence of the protecting compresses; it is much better to follow the method recommended by M. Quénu:[1] the gangrenous

[1] Quénu, "De l'intervention chirurgicale dans les ruptures spontanées du rectum." *Semaine médicale*, 1888, p. 26.

portion of the loop will be removed first of all by the rectum, by ligating each of the two limbs and cutting away the bowel below the ligatures; after cleansing the cut edges as carefully as possible, the abdomen will be opened and the two ends withdrawn as before, and the enterectomy completed as circumstances permit: by circular enterorrhaphy, or lateral implantation if the prolongation of the operation is justified by the condition of the patient; or by simply securing the two ends in the parietal wound if it is necessary to finish as speedily as possible.

FOREIGN BODIES IN THE RECTUM.

It is impossible to mention here all the foreign bodies which may from time to time be found in the rectum, nor can we describe the numerous methods and instruments whereby their extraction has been effected. It must suffice to emphasize certain general rules, and to indicate the chief lines of treatment.

When the difficulties so often associated with extraction are taken into consideration, when the prolonged, forcible, and ill-guided manipulations, the lacerations of the mucous membrane, or even of the whole thickness of the rectal wall, and the resulting complications, are recalled, the need for methodical treatment is perfectly evident.

It would be a mistake, however, as M. Monod has shown, to exaggerate the frequency of mishaps in these cases: out of 34 cases collected by him, the foreign body was removed by the natural passages in 27, and in these 27 cases there were 5 deaths, of which only 3 appeared to be due to the attempts at extraction. In a word, there were 3 "avoidable" deaths, much too high a percentage.

The surgeon has been called to see a person who has, on the previous evening or some hours before, introduced a foreign body of some sort, a bottle, a tumbler, a glass, a piece of wood (the possible objects are beyond enumeration), into the rectum. A confession has been obtained, sometimes not without trouble; very often, indeed, the doctor is summoned on some pretext such as simple constipation, quite foreign to the true nature of the condition. The scepticism of the medical practitioner, especially with regard to conditions relating to the natural orifices of the body, must be unlimited.

Assuming that a confession has been obtained, and consequently the nature of the foreign body is known, one must not of course remain satisfied with the information given; an immediate examination is necessary to determine the exact nature of the condition.

Lubricate the anal region freely with vaseline, and introduce a finger into the rectum; sometimes the foreign body will be found lying close at hand, in a good position in the bowel, mobile, and with a smooth rounded surface, and extraction with the fingers or suitable forceps will be achieved without trouble.

Do not, however, rely upon succeeding so easily, and if you find that the foreign body is lodged in the hollow of the sacrum, if it is impacted, fixed, or if it distends the rectum, do not persist with the attempts at immediate extraction, but proceed at once to make the necessary preparations for carrying out methodically a task which is often exceedingly troublesome.

Have the patient anæsthetized, if general anæsthesia is at all possible. Anæsthesia is almost indispensable; apart altogether from protecting the patient from pain, it will enormously simplify the manipulations and eliminate the risk of serious accidents; and anæsthesia is not to be considered as a last resource, only to be adopted after the failure of prolonged and ill-ordered attempts at extraction; it must be administered primarily; *it is the first step in a properly-regulated operation.*

Then place your patient in the lithotomy position, with the thighs well separated and flexed and properly secured; with the pelvis raised by a large pillow, and the anal region well illuminated.

Dilate the anus slowly with the fingers, and as thoroughly as possible. Now explore the rectum, and before making any attempt at traction, try to determine exactly the "presentation" of the foreign body.

The nature of the conditions varies widely, according to the special characters of the foreign bodies, but in general terms it may be said that they fall into three chief groups:—

1. **The foreign body is of large size,** and fills the rectum so completely that the examining finger can only be insinuated with great difficulty between it and the rectal wall.

2. **The foreign body is long and cylindrical, and is imprisoned in the hollow of the sacrum.** The mechanism of this incarceration, in which the coccyx plays an important part, has been investigated by Pierre Delbet.[1]

His case related to a bottle, 10 in. long, $2\frac{1}{4}$ in. in diameter, and 7 in. in circumference at its widest part; it is especially with foreign bodies of this type that incarceration occurs most frequently and definitely.

The bottle had been introduced neck first, and, once in the rectum, it occupied the position shown in *Fig.* 101; it lay almost horizontally, with the neck forwards and to the left; the base was lodged in the sacral hollow, and the coccyx curved forwards below it.

As we shall see immediately, unless the coccyx is first strongly depressed or excised, and if the traction is applied directly to the bottle, grasped very obliquely near its base, all attempts at removal will fail.

3. **The foreign body is sharp pointed at one or both extremities, or has superficial irregularities, and is implanted** at one or more

[1] Pierre Delbet, "Des corps étrangers du rectum (à propos d'une bouteille)." Rapport de G. Marchant, *Bull. de la Soc. de Chir.*, 3 nov., 1897, p. 652, and "Corps étrangers du rectum. Mécanisme de l'enclavement des corps étrangers longs et volumineux." *Gazette hebdom.*, 11 nov., 1897, No. 90, p. 1069.

points in the wall of the rectum. Direct, blind traction in such a case will be not only unsuccessful, but extremely dangerous.

It is therefore absolutely necessary that the conditions and the difficulties should be recognized first of all, and that the work of extraction should be pursued methodically in the following manner:

Introduce a broad and long rectal retractor (*Fig.* 100) into the anus and pass it in as far as possible, guiding it with the finger between the foreign body and the wall of the rectum; *endeavour to pass the retractor above the coccyx, and then, by inclining the instrument strongly, depress and straighten out the bone as completely as possible.*

If the patient is young, the coccyx mobile, and the foreign body of moderate size, little difficulty will be experienced; and, once the retractor is in good position, the channel will become much more free. In the opposite conditions, the manœuvre will sometimes be impracticable, and it will be necessary, after a few careful attempts, to have recourse to one of the open methods which we shall mention presently.

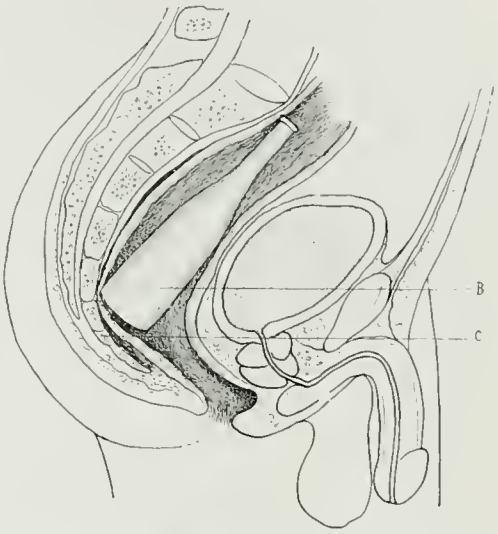


Fig. 101.—Foreign body (bottle) incarcerated in the rectum. (B) Bottle resting on the base of the coccyx. (C) coccyx.

I assume, however, that the retractor is in position, or, if the necessary instruments are lacking, that the left index and middle fingers have been introduced into the bowel, and that the coccyx yields and allows itself to be displaced without much difficulty. The way is now clear for seizing and attempting **to withdraw** the foreign body.

The fingers alone will sometimes be sufficient to effect extraction, or at any rate, by freeing or by inclining the accessible end of the foreign body, they may succeed in bringing it into a position whence its extraction may be completed without trouble.

More often, however, an instrument of some kind, as lion forceps, clamp forceps, or scoop, is necessary, particularly when the body to be extracted is large, because a very considerable effort may then be required.

On a soft rough surface such as wood any instrument will "bite," and if properly applied will not slip; it is a very different matter when the surface is hard and smooth, glass objects for instance, bottles, etc., which have the additional disadvantage of being fragile; forceps slip, and exercise

no useful effect ; while, if the pressure of the jaws is increased, there is a serious risk of breaking the object and of embedding some of the fragments in the wall of the rectum. If, however, the blades of the forceps are sheathed with rubber, it will be possible to apply sufficient traction without risk of slipping or breaking.

A small midwifery forceps is sometimes a very suitable instrument for the extraction of large foreign bodies ; its employment has been attended with very satisfactory results in cases where it has been possible to introduce the blades separately, and to apply them properly.

If the foreign body is incarcerated, if it is for instance a bottle (*Fig.* 101), the base of which rests on the coccyx and the neck can be felt on palpation above and to the left in the iliac fossa, the first step is to try to overcome the principal obstacle to removal by retracting the coccyx strongly backwards ; it may then be possible by pulling the base of the bottle downwards and a little forwards to deliver it.

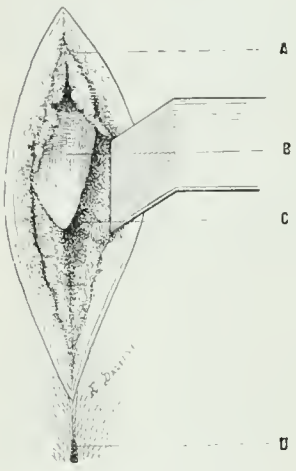


Fig. 102.—Resection of the coccyx 1st step : Retro-anal incision, exposure of the coccyx. (A) Upper extremity of the incision. (B) Coccyx. (C) Recto-coccygeal fatty tissue. (D) Anus.

By combined internal and external manipulations, by pressure above the pubis and with a hand in the rectum, MM. Casteret and Daunic succeeded in extracting a bottle which measured 8 in. in length, 6 in. in circumference, and which lay almost horizontally at a very high level. While deep pressure was exerted in the suprapubic region, the fingers of the right hand were passed into the rectum as far as the metacarpo-phalangeal joints, the dorsal surface was directed backwards against the coccyx and the thumb in front, and the fingers were gradually insinuated between the rectal wall and the bottom of the bottle. Finally the bottle, pushed down from above and disengaged from below, slipped into the fingers and was extracted.[1]

The displacement of the coccyx is the principal and also the most difficult step : as soon as the lower extremity of the foreign body has been disengaged from the tip of the bone, removal can usually be completed without much trouble.[2]

If the coccyx cannot be displaced, it is useless to continue the attempts, which must of necessity be fruitless ; the foreign body may of

[1] Casteret et Daunic, "Extraction d'une bouteille du rectum." *Bulletin médical*, 6 septembre, 1902, No. 71, p. 767.

[2] See an interesting case recorded by Bazy (*Bull. de la Soc. de Chir.*, 3 nov., 1897, p. 656). It related to a bottle introduced into the rectum : the first attempts at removal under chloroform failed ; next day a posterior retractor was placed in the rectum and the coccyx depressed ; the bottle was then extracted with the greatest ease.

course be removed piecemeal if it can be easily cut or broken up, and if the fragments will not damage the bowel.[1]

When one has to do with a **rod fixed in the rectal wall**, the first care must be to disengage the implanted end before making any attempt at extraction ; if both ends of the rod have penetrated the mucous membrane, and it is found stretching between two points of the rectal wall, it will sometimes be possible to cut it in two, or to break it up, and then to extract the fragments one by one. In such circumstances wide dilatation of the lower segment of the rectum with retractors greatly facilitates the work.

Extraction by the natural passages is undoubtedly the method of choice, but the manipulations must always be carried out carefully and systematically, and in the face of insurmountable difficulties the operator should know when to stop and have recourse in time to more suitable measures.

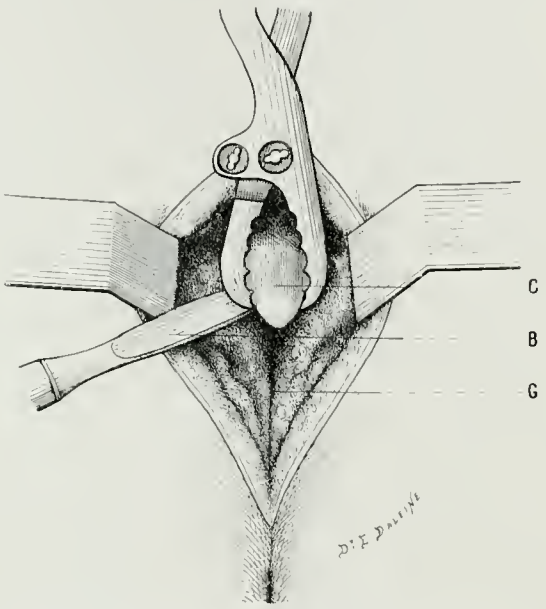


Fig. 103.– Resection of the coccyx. 2nd step ; The coccyx is seized with lion forceps and dislocated backwards. (C) Coccyx. (B) Knife freeing the anterior surface of the coccyx. (G) Recto-coccygeal fatty tissue.

If the foreign body distends the anal canal to such a degree that it becomes impossible to get hold of it, and even impossible to slip the blades of the forceps up between it and the rectal wall to a sufficient height, then **the anus must be incised in the middle line posteriorly**, and the incision be continued up the posterior aspect of the rectum, keeping strictly to the middle line, for a distance corresponding to the exigencies of the situation. The incision should be made with the scalpel, because it will be sutured after the foreign body has been removed.

Begin by washing and preparing the sacro-coccygeal region and the accessible portion of the rectal cavity ; then incise the skin from the anus to the tip of the coccyx ; push a large grooved director by way of the wound through the wall of the rectum, make its point emerge from the anus, and

[1] Thus Broussin, of Versailles, succeeded in extracting in fragments, with pressure-forceps, a sausage which a man, forty years of age, had introduced into his rectum. (" Rapport de Bazy," in *Bull. de a Soc. de Chir.*, 3 nov., 1807, p. 659.)

on it divide the posterior ano-rectal wall : forceps are applied to the bleeding vessels and serve at the same time to secure and retract the two flaps. When the foreign body is situated at a very high level, it may be necessary to extend the way of access by resecting the coccyx.

Resection of the coccyx is particularly necessary when dealing with a body incarcerated in the manner already described, and when it is impossible to sufficiently displace the bone by means of a retractor introduced by the anus. In such circumstances posterior proctotomy alone would be insufficient ; the coccyx must be excised, since it cannot be displaced.

When it is recognized that the coccyx is the chief obstacle which prevents extraction of the foreign body, it is good practice to resect the bone first, at least if it has been possible to dilate the lower rectal segment satisfactorily, and then to attempt extraction, leaving the incision of the posterior rectal wall to be made later if it should prove necessary.

Make a median cutaneous incision, beginning a finger-breadth behind the anus and extending upwards to the middle of the sacrum : carry the incision down to the coccyx and free the posterior surface and tip of the bone (*Fig.* 102) by rapid dissection with the scalpel ; grasp the tip with lion forceps and draw it backwards, while the knife continues the separation of the borders and the anterior surface from the soft tissues (*Fig.* 103) : when the first coccygeal segment is reached, divide it transversely with bone-cutting forceps.

This only needs a few seconds for its performance ; there is nothing to fear, no organ to damage, if the anterior surface is sufficiently freed before the bone is resected. Not uncommonly it happens that in following the anterior surface with the knife, while the coccyx is at the same time drawn strongly backwards, the articulation between the first and second segments is opened ; the disarticulation can be completed by one or two touches with the point of the knife, and will often be sufficient ; but if the first coccygeal segment is markedly curved forward, it can be removed in a moment with the bone-cutting forceps.

The attempts at removal are then resumed, and are as a rule successful, provided that it is possible to loosen the foreign body and to get hold of its lower end. If any difficulty is experienced in carrying out the latter step, it is a very simple matter to provide free and direct access by incising the anus and the posterior rectal wall.

The resection of the coccyx causes no after-disability. The ano-rectal incision must be closed with the greatest care. The two mucous edges are adjusted by a first row of sutures, or better by a continuous catgut suture ; the cut outer coats are now united by a second row of sutures including the whole thickness of the rectal wall with the exception of the mucous lining, on either side : the sutures are best introduced with a large curved needle, Emmet's needle, for instance, if one is at hand ; at the posterior anal commissure, special attention must be directed to the restoration of the anal sphincter ; closure of the skin wound by a series of cutaneous sutures completes the operation.

A word is necessary with regard to **foreign bodies which have been**

pushed very high up into the rectum or into the sigmoid colon, and are inaccessible by the anal route. It must not be forgotten that this unfortunate position is sometimes due to ill-directed exploratory manœuvres or attempts at extraction, and for that reason it is always necessary to keep a hand applied over the left iliac region for the purpose of steadying and pushing down the foreign body while attempts are being made to seize it from below.

In these exceptional cases, one may try to mobilize and displace the foreign body downwards by carefully regulated pressure applied through the abdominal wall; usually, however, these external manipulations are not attended with much success, and great caution is necessary in their application, because ruptures or perforations may readily be caused.

If these efforts fail, there remains only a single resource: laparotomy along the outer border of the rectus muscle on the left side. The attempts at displacement may then be resumed under the guidance of the eyes. But it will be well not to persist too long; the best line of treatment consists in incising the intestinal wall to a sufficient extent, extracting the foreign body, and closing the opening at once by careful suturing. The three first cases in which this method was adopted, one of which dates from 1848, terminated favourably.[1]

URGENT ANAL DILATATION.

We have seen that dilatation of the anal sphincter is an essential preliminary in dealing with rectal wounds, foreign bodies, etc. In certain painful contractures of the sphincter and in hæmorrhoidal strangulation it is also a necessary measure, which may indeed be rendered immediately urgent by the intensity of the pain and the local conditions.

A very stout man, some fifty years of age, who had for a long time suffered from piles, was brought to us in a condition of intense suffering. Five days previously, during defæcation, a huge mass had been suddenly protruded from the anus, and all attempts at reposition had been unsuccessful; the protrusion had increased in size and was associated with a bloody discharge, intense lancinating pains, and almost continuous tenesmus, which was increased by the slightest movement or the least expulsive effort. Defæcation was impossible, micturition was very difficult, the skin was hot, the tongue dry, and the temperature 102°.

[1] The cases are those of Réalli (1848), of Studgaard of Copenhagen (1878), and a third recorded in *l'Histoire de la guerre d'Amérique*. Réalli's case is particularly curious: it related to a peasant who had introduced a wooden peg into his rectum, eight days before. The finger could just touch the end, and "it was so firmly fixed, and so poor a hold could be obtained, that it yielded not in the slightest degree to any traction which could be applied." After the abdominal wall had been incised on the left side, the peg could be felt quite distinctly in the descending colon. It could not be pushed down, so the wall of the gut was incised. "It was then possible to withdraw the foreign body, which was 4 inches long and 1¼ inches in diameter at the base. The intestinal wound was closed by Jobert's method. The bowels acted on the fifth day; the wound had healed at the end of six weeks. Two years later the man was in perfect health."—*See* Poulet, *Traité des corps étrangers*, p. 357.

The anal region was occupied by an enormous mushroom-shaped mass, blackish in colour, nodulated in its central portion, and surrounded by a thick circular ridge ; the most centrally situated nodules were greyish, prominent, and covered by a putrid and extremely fœtid layer ; on separating them—a procedure which was effected with considerable difficulty and great increase of the patient's sufferings—the narrow orifice of the anus was seen between them ; when an attempt was made to pass the little finger into the orifice, it met with an invincible resistance, a circular constriction which arrested its progress at once.

Internal hæmorrhoids, prolapsed en masse and strangulated by the contracted sphincter ani. Such was the diagnosis. What was to be done ?

Undoubtedly, rest in bed, the application of large moist dressings, and the administration of opium, sometimes suffice to relieve the acute symptoms ; but in the case in question the situation was too urgent ; the patient had suffered too much and for too long a time ; gangrene and secondary complications were too probable to allow of any delay.

There remains still a " heroic " method of relieving the pain and the strangulation : that is **anal dilatation.**

Fig. 104.—Anal dilatation in a case of strangulated hæmorrhoids. Position of the hands. Introduction of the thumbs.

Have the patient carefully anæsthetized ; cleanse the anal region, the protruding mass, and all its folds. Then pass one of your thumbs, well lubricated, gently into the anus ; introduce the other thumb ; push both as high up as possible, well above the ring of the sphincter, which can be plainly felt on either side. Then, only when the two dilating thumbs are in good position, begin the stretching of the sphincter (*Fig.* 104).

Do not attempt to effect it by a single forcible movement, as if trying to break down a rigid obstacle ; it is the resistance of a living, spasmodically contracted muscle that has to be overcome. Therefore work steadily, without jerks, with a continuous movement, gradually approximating your thumbs to your other fingers, which are applied over, and take their points of support from, the ischial tuberosities on either side.

Do not be satisfied with simply dilating transversely, but stretch the

[1] In *Fig.* 104, which is reproduced from a photograph, the patient is lying on the abdomen with the legs hanging over the edge of the bed. It is an unusual position and one which has little to recommend it : as a rule the patient ought to be placed in the lithotomy position, with the thighs well flexed and the buttocks raised, or on the side, with the upper thigh flexed and the lower thigh extended.

sphincter all round its circumference, and continue the process until all resistance has disappeared and the orifice remains gaping.

It is important to know how to effect anal dilatation with the thumbs; it will be properly done if the instructions just given are followed, and if it is recognized that the procedure does not consist in a rapid, forcible movement, but in slow, steady, and complete stretching.

If Trelat's speculum or a dilator is used, the same method of slow, steady dilatation, acting all round the anus, must be followed; this alone will give the maximum benefits with the minimum of risks.

IRREDUCIBLE OR STRANGULATED RECTAL PROLAPSE.

Let us in the first place illustrate this condition by two examples.

Case 12.—A man, 55 years of age, was brought into my hospital service with the enormous mass represented in *Fig.* 105 protruding in the anal region. For several years the bowel had come down every time he went to stool, and considerable difficulty had been experienced in replacing it; on three occasions the prolapse

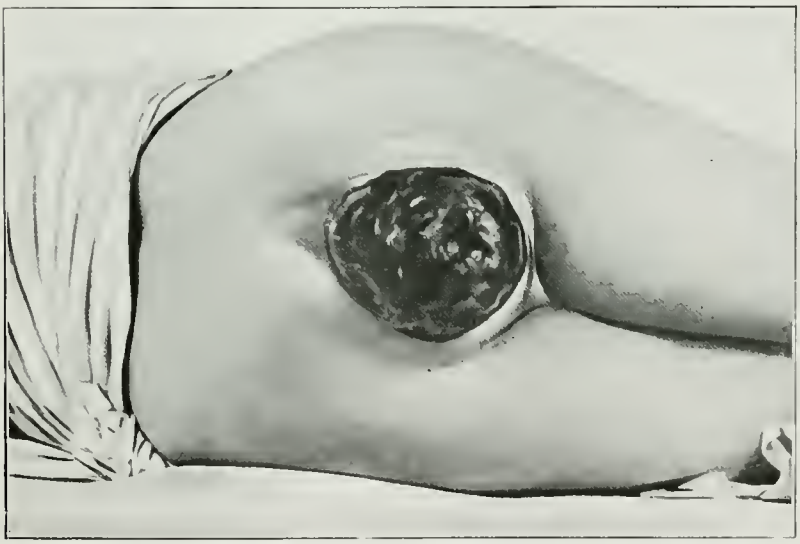


Fig. 105.—Strangulated rectal prolapse.

had been temporarily irreducible, and had only yielded at the end of twenty-four or thirty-six hours and after repeated attempts. This time the accident had occurred on the previous evening, and the mass was larger than it had ever been. All attempts at reduction had been unsuccessful. Protruding from the anus there was a cylindrical mass as large as two fists, smooth and tense in its central part, and marked by transverse folds at the base. It was of a

dark red colour, dense, almost hard in consistence, particularly in its posterior portion, and was moderately curved backwards; at its apex there was the orifice of the intestine, and its base was encircled by a shallow groove which separated it from the anus.

In my turn, I set myself to try to reduce it. The patient having been placed in the genu-pectoral position and the whole surface of the mass freely covered with vaseline, I applied steady pressure to it as a whole with the idea of reducing its volume; then I tried, slowly and methodically, to return the central portion. I failed absolutely: the protrusion felt like a solid mass, which did not yield in the slightest to my efforts.

However, I thought it possible to wait till the following day before attempting anything further; the patient was put to bed on his side, and the prolapse was enveloped with moist compresses. Next day, the irreducibility remained as before; but the congested, dusky, lustreless surface of the protrusion indicated the need for immediate action. I resected the prolapse by Mickulicz' method as follows: an anterior transverse incision down to the peritoneum, which was found empty and was at once closed by a series of catgut sutures: the internal layer was divided and the two mucous edges united. The anterior portion of the mass being thus detached, I proceeded to deal with the posterior portion in a similar manner: section of the external layer, section of a thick mass of fatty tissue representing the meso-rectum and containing many vessels, which were caught and tied; section of the inner layer and suture of the two cut edges. There only remained then a circular line of suture, which reduced itself spontaneously.

An irreducible prolapse tends to become gangrenous very rapidly, and resection is then necessary, often under very serious conditions.

Case 13.—A woman, 23 years of age, was admitted to the Beaujon Hospital on June 8th, 1907, with an irreducible and gangrenous rectal prolapse of eight days' standing. The mass was of a brownish colour, marbled with greenish patches and extremely fœtid. The general symptoms were very alarming: fever, rapid and feeble pulse, dyspnœa, vomiting, almost continuous, of greenish material, very acute pain, pale and pinched face. Resection was performed forthwith; the prolapse was divided into two portions, which were cut away one after the other, the cut edges being united step by step as the resection advanced. In front the peritoneal cul-de-sac was found empty, as in the previous case, and about a tablespoonful of blackish fœtid fluid escaped from it; the serous membrane was greenish and apparently gangrenous to a height of about an inch. The two layers were united above the level of the necrotic zone in the manner indicated above.

This extensive resection was followed by a rapid disappearance of the toxic symptoms; healing took place without any complications, and the patient left hospital on the 26th June.

The two cases just quoted were examples of *complete prolapse*; *mucous prolapse*, which is comparatively common in infancy and old age, may also be irreducible or strangulated; reduction is as a general rule more simple, and the prognosis is always less grave.

In dealing with a prolapse, whatever the variety may be, which is tending to become strangulated, the correct line of treatment is as follows:—

1. **The Prolapse has been down for a relatively Short Time it is more or less Congested and Œdematous, but is not yet Gangrenous.**—Reduce it, or at any rate begin with methodical attempts

at reduction. If the patient is a child, have him held up before you or hold him yourself between your knees, head downwards ; if an adult, have him placed in the genu-pectoral position, with the thighs well separated. General anæsthesia will often be useful, and then the patient must be placed on the side ; but care must always be taken to have the pelvis raised as high as possible.

After having lubricated it and also the surrounding area with vaseline, the prolapsus is covered with a large compress, and the attempt at reduction is begun by the exercise of gentle, steady, concentric pressure with both hands, then longitudinal pressure from apex to base, over the whole of the protruding mass. Do not seek to reduce the mass at once ; try to empty

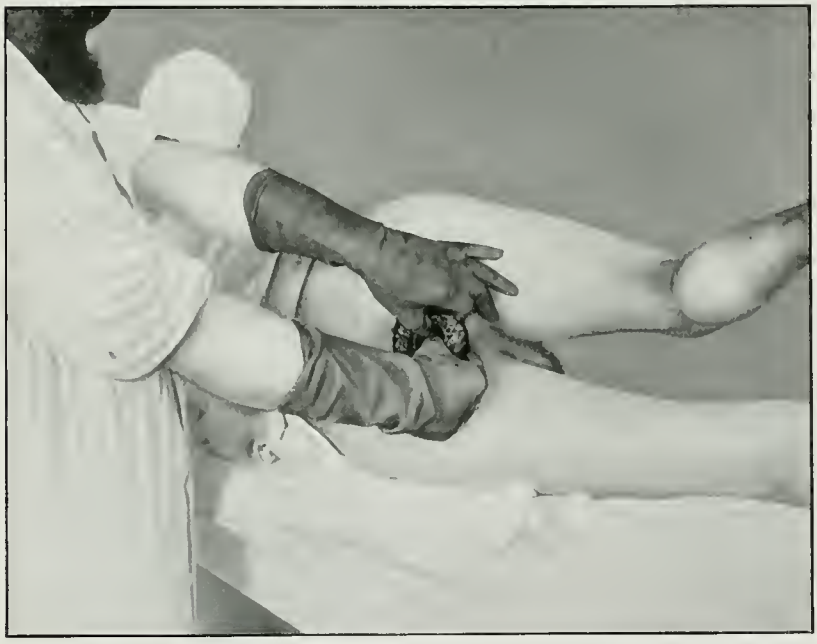


Fig. 106.—Reduction of a rectal prolapse.

it, to compress it ; when it has been softened and reduced in size by systematic pressure, an attempt may be made to reduce it. To effect this the pressure must be applied to the centre of the apex in a direction from below upwards ; it is the " head " of the prolapse which ought to be returned first, and will draw the rest behind it. Place a thumb on either side of the central orifice, while the separated fingers of your two hands rest against the margins of the anus and push directly in the axis of the mass ; as soon as the rectal wall begins to yield under the pressure, continue the movement, changing the position of the thumbs as bit by bit the outer layer slips back through the orifice (*Fig.* 106).

The manipulations must always be conducted gently, cautiously, and patiently; the œdematous and infiltrated rectal walls are often very friable; they may be fissured or torn, or stripped of mucous membrane, by the slightest roughness; and in any case reduction is not a matter of force, but of continuous, prolonged, and well-directed pressure.

Fig. 107.—Resection of a rectal prolapse. (Mickulicz' method.) 1st step: Section of the anterior semi-circumference of the outer tube; continuous suture of the two peritoneal layers, closing the peritoneal cavity. (*aa'*) Mucosa. (*b*) Continuous suture uniting the serous surfaces of the outer and inner tubes.

If, after ten or fifteen minutes' methodical work, no positive result has been obtained, if the prolapsed mass has not become softer, if it has not yielded even a little, it will be advisable to desist. When the irreducibility is still quite recent, and there are no signs of impending gangrene, the situation does not demand an immediate decision. Still, it must be recognized that nothing is to be gained by waiting. Apart from some cases of mucous prolapse, the factors which cause the irreducibility will undergo no favourable change during the following hours; indeed, no matter what is done, the congestion will increase, the prolapse will become thicker, and more and more altered, and finally it will be compulsory to take the only rational course, *resection*.

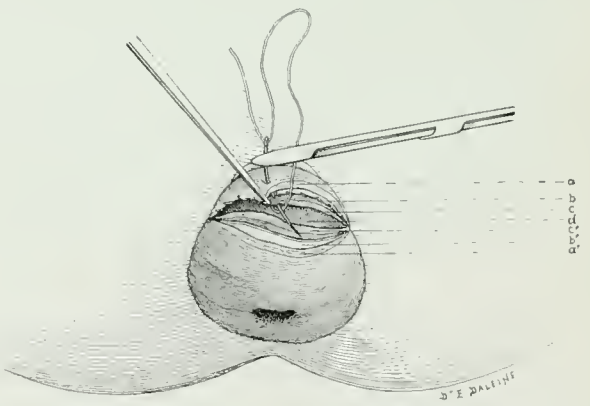


Fig. 108.—Resection of a rectal prolapse. 2nd step: Section of the anterior semi-circumference; uniting the cut edges of the outer and inner tubes. (*a*) Outer tube. (*b*) Continuous suture of the two peritoneal layers. (*c*) Inner tube. (*d*) Rectal cavity. (*c'*) Peritoneal coat. (*b'*) Muscular coat. (*a'*) Mucous coat.

2. **Reduction is impossible, and the Prolapse is showing signs of Gangrene or is already Gangrenous.**—In any of these conditions, the prolapse must be removed like a tumour. In the case of a *mucous*

prolapse, excision is a comparatively simple matter. The protrusion is seized with two forceps, and then split longitudinally in the middle line in front and behind; next, the anterior incision is continued bit by bit around the base of the left portion from before backwards, the cut mucous edges being united as the incision advances; the right half is cut away, and the edges sutured in the same manner.

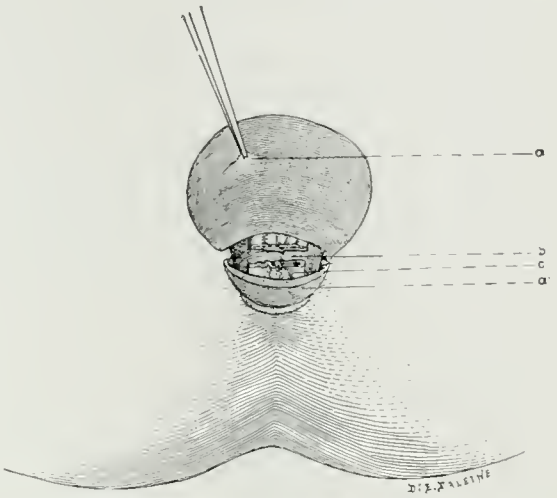


Fig. 109.—Resection of a rectal prolapse. 3rd step: Section of the posterior semi-circumference; section of the mesorectum; ligatures. (*a*) The prolapse turned forwards. (*b*) Inner tube. (*c*) Section of the mesorectum. (*a'*) Outer tube.

Operation is more difficult in a case of a *complete prolapse*; the necessity of first opening the anterior peritoneal cul-de-sac, of reducing the contents, if any, of the sac, and of closing the peritoneum, determines the technique of the resection.

Open the peritoneum at once. The prolapse being stretched and made taut by two traction forceps fixed to its apex, make a transverse incision across the anterior half of its circumference close to the base; divide the wall of the outer tube carefully, layer by layer—mucosa, muscular coat, and serous coat—lifting up the inner coat with the dissecting forceps before incising it, because under it may be found a loop of intestine. As soon as the serous coat of the bowel has been divided, a narrow, smooth-walled space comes into view, extending to a variable distance on either side, in other words, the anterior peritoneal cul-de-sac. Reduce any intestine or omentum which may be contained in the sac, and, before going farther, close the peritoneum by uniting the two serous layers by a continuous suture of fine catgut introduced from left to right with a curved needle (*Fig.* 107) or the two

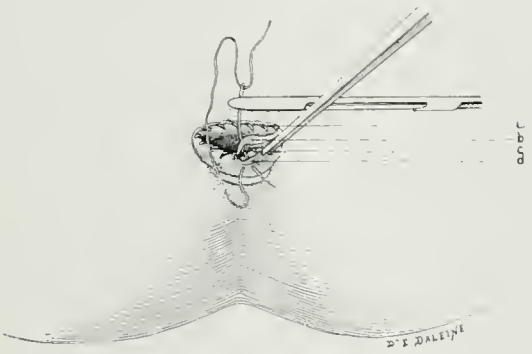


Fig. 110.—Resection of a rectal prolapse. 4th step: Uniting the two posterior cut edges. (*a*) The two anterior cut edges, sutured. (*b*) Inner tube. (*c*) The meso-rectum, divided and ligated. (*d*) Outer tube.

layers may be united by a series of U-sutures. Remember that the cul-de-sac is crescentic in shape, and that the horns extend laterally; therefore extend the incision and the occluding suture to its limits.

Once the peritoneal cavity is shut off, but not before, the inner tube of the prolapse will be incised—serous coat, muscular coat, mucous membrane—till the lumen of the intestine is reached; the two cut edges of the outer and inner tubes will be at once carefully united by interrupted sutures, or better, by a continuous suture which, while giving accurate adjustment, also insures hæmostasis (*Fig.* 108). Now have the prolapse drawn forwards, and incise the posterior semi-circumference of the outer tube: underneath, it is not peritoneum which will be found, but a layer of fatty tissue, often thick and dense, which represents the central portion of the mesorectum; in this œdematous fat there is a considerable number of vessels; secure them with pressure forceps as they are divided, and continue the incision down to the outer wall of the inner tube (*Fig.* 109). Cut this in its turn, and then the entire prolapse will be free. Carefully ligate the vessels in the mesorectum, and, after having made sure that all bleeding is checked, proceed to the posterior half of the suture. As before, the two cut walls must be approximated as accurately as possible (*Fig.* 110). There is then only a single circular line of suture (*Fig.* 111), which reduces itself spontaneously and ascends to a little distance above the anus.

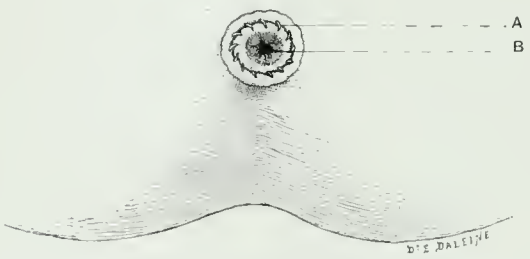


Fig. 111.—Resection of a rectal prolapse. The operation completed; circular line of suture which is about to be reduced. (A) Continuous suture. (B) Rectal cavity.

Another, and more expeditious method, has been recommended by Segond and Nélaton, by means of which the time the peritoneum remains open is reduced to a minimum, and it is therefore suitable for dealing with cases in which the prolapse is gangrenous, with the reservation, however, that it has been made certain, by palpation of the anterior portion of the prolapse, that the peritoneal cul-de-sac is empty. Two long clamps are placed longitudinally on the prolapse, which is then cut between them, so as to divide it into anterior and posterior halves. Another clamp is then applied transversely to the base of each half. The halves are then cut away one after the other, and bit by bit, the suture following each step of the section, and the clamps being shifted outwards as the work proceeds. Hæmorrhage is thus reduced to a minimum, and, as the peritoneum is closed as soon as it is opened, it is protected from the risk of infection.[1]

[1] These operations have their place here only as urgent procedures: we must simply add, that after such extensive excisions the anus often remains patulous, and a subsequent recto-perineorrhaphy is usually necessary to correct the infirmity.

ABSCESSES OF THE ANUS AND RECTUM.

Very little need be said about *the small submucous abscesses*, which are often of phlebitic origin; they must be opened *early and freely*, that is all; a good many fistulæ would be prevented if this rule were strictly followed.

The same principle is applicable to the treatment of the **large marginal abscesses, ischiorectal abscesses,** and the **deep abscesses in the upper pelvi-rectal space.**

A subcutaneo-mucous abscess at the anal margin ought to be opened in the same way as a fistula is incised. The incision must extend the full length of the mucous separation, right to the bottom of the upper prolongation of the cavity, at whatever height above the anus it may lie; this is the essential condition for healing without the formation of a fistula. The incision involves only the skin and the mucous membrane; the sphincter lies external to the abscess, which has developed altogether to the inner side.

Fig. 112.—Incision of a marginal abscess of the anus. 1st step: Puncture of the abscess, externally.

Open the abscess near its outer border by a touch with the point of the knife (*Fig.* 112); slip a grooved director into the opening, and carry it upwards and inwards to the upper limit of the cavity; with a sharp thrust make its tip perforate the inner wall and emerge from the anus, and then divide the overlying cutaneo-mucous bridge (*Fig.* 113).

When the abscess extends high up, care must be taken to retract the opposite wall of the rectum as much as possible, and with the index finger in the bowel to guide the tip of the director to the extreme upper limit of the abscess cavity; right at the top of the cavity, and there only, should the instrument perforate the mucous membrane. Once the incision has been properly made, it only remains to cleanse the suppurating cavity and, with a snip of the scissors, to excise the thinned, congested mucous edges, so transforming the cavity into a flat raw surface, in which condition it should be kept while it heals by granulation. A strip of gauze should be introduced to the extreme limit of the raw surface, and renewed regularly till cicatrization is complete, for the sole purpose of insuring healing from the bottom.

The situation is more difficult in the case of a large **abscess in the ischiorectal fossa.**

When a thick, tense painful swelling is found filling all the space between the ischium and the anus, and even encroaching on the buttock and the perineum, and feeling like a hard, solid mass, do not wait for definite fluctuation; the lancinating pain, the fever, the ischiorectal induration, the rounded swelling, sometimes covered with reddened and œdematous skin, are sufficient indications of the presence of pus. Incise it; any delay will simply result in further extension in the deeper planes, and wider separation of the rectal wall.

Make an *incision, antero-posterior*, or slightly oblique from in front, backwards and outwards, at a finger's breadth from the anus, over the summit of the swelling: make a very long incision—3 to 4 in. in length—and cut down boldly through the skin and the other tissues to the centre of the mass; there is a good deal of bleeding from the sides of the large incision, but it ceases spontaneosuly without causing any trouble; if alone, one may, however, employ the thermo-cautery, which is specially indicated in the case of gangrenous abscess.

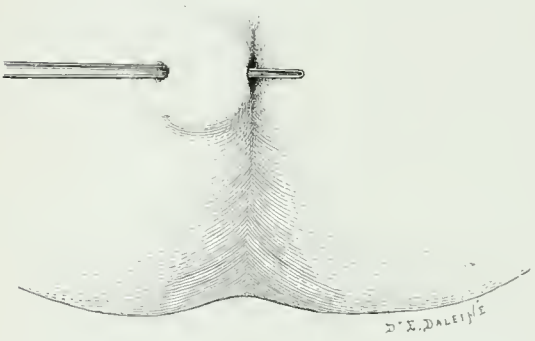


Fig. 113.—Incision of a marginal abscess of the anus 2nd step: The grooved director underlies the whole infero-internal wall and emerges on the mucous surface. Section of the cutaneo-mucous bridge.

The brownish, horribly fœtid pus escapes, mixed sometimes with putrefying débris: cleanse the cavity by free irrigation, then examine it carefully with eye and finger, and make sure that no pus continues to flow from the roof of the space through an opening in the levator ani.

Examine also the rectal wall; break down any septa, and thus convert the cavity into a large conical space with its base superficial, and in it place a large drainage tube and a strip of lightly-packed gauze.

Pararectal incision performed in this manner will result in rapid and complete healing, in cases of abscess of moderate size, strictly limited to the ischiorectal fossa, with the double reservation, however, (*a*) that it is *made early and is very large*, and (*b*) that *healing is carefully watched and controlled*, and takes place from the bottom of the cavity.

It is a different matter, however, when operation has been delayed, and the abscess has stripped up the rectal wall and can be felt bulging into the rectum, close under the mucous membrane; or when pus has already been discharged by the anus.

In such circumstances a fistula, if not already present, is inevitable, and perfect healing can only be obtained **by incising the anal sphincter and the lower part of the rectal wall.**

Puncture the abscess over the ischiorectal fossa with the scalpel, and through the opening pass a strong grooved director from without inwards and from below upwards to the supero-internal limit of the abscess cavity close to the rectal wall; push the tip of the director through the rectal wall and bring it out at the anus, and then divide the thick wall of tissue with the thermo-cautery. The opening will sometimes be of enormous size; it must go right to the upper limit of the cavity and must heal from the bottom towards the surface. It may be months before healing is complete; but the free primary opening up, while cutting short the advance of the suppuration, has the great additional advantage of hastening permanent healing by preventing the formation of a fistula.

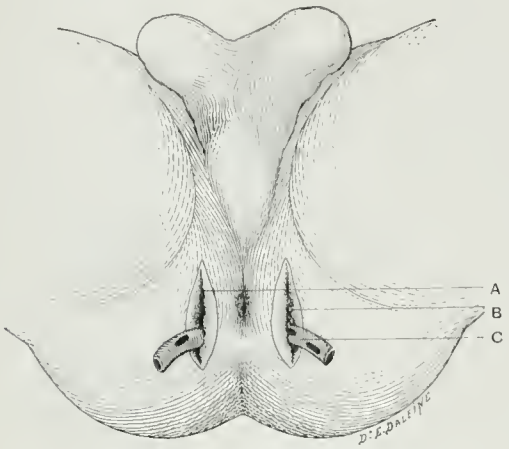


Fig. 114.—Incision of a double ischiorectal abscess (horse-shoe abscess). (A) Right ischiorectal incision. (B) Corresponding incision on the left side. (C) Drainage tube passing from one opening to the other, behind the anus.

Again, it may be that the suppuration has invaded both ischiorectal fossæ and the intervening ano-coccygeal space, so forming a large horse-shoe abscess behind and on either side of the anus: two lateral incisions should then be made, and a large drainage tube passed from one to the other in front of the coccyx (*Fig.* 114); or if the retro-anal separation is very extensive, the lateral incisions should be united by a curved posterior one.

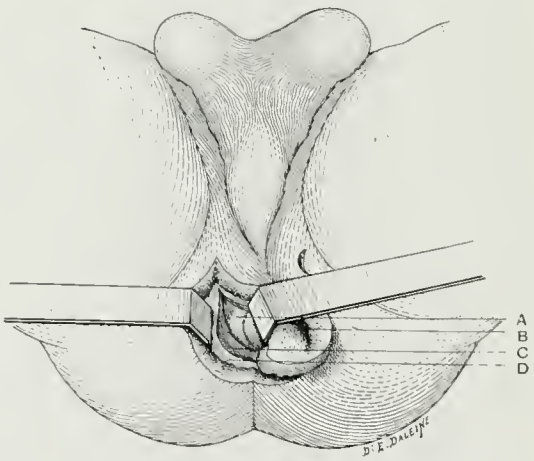


Fig. 115.—Incision of an abscess in the upper pelvi-rectal space. (A) Levator ani, stretched by the abscess. (B) Anus. (C) Border of the gluteus maximus. (D) Ischial tuberosity.

In the case of a **deep abscess in the upper pelvi-rectal space**, an early diagnosis is often difficult. The external examination gives no information; but on rectal exploration it is possible to feel, at one side or other of the bowel, an infiltrated area, thick and

tender, or sometimes even doubtfully fluctuating; the fever and the general symptoms will allow no doubt as to the nature of the swelling.

It is of the utmost importance to open these deep-seated accumulations at the earliest possible time, because they tend to spread into the pelvis on the one hand, and on the other to become the origin of fistulous tracks which are extremely difficult to cure.

They must therefore be sought for in good time, through a large antero-posterior ischiorectal incision, which must be steadily deepened from before backwards, layer by layer, through the levator ani, till the pus is reached (*Fig.* 115), or by means of a median ano-coccygeal incision which, by opening up the recto-rectal cellular tissue, will provide access to the levator and to the collection of pus lodged above it.

SECTION IX.

THE STRANGULATED HERNIÆ.

THE URGENT INDICATIONS IN STRANGULATED HERNIA.

When a hernia becomes irreducible, tense and painful, when it is complicated by vomiting and obstruction of the bowels, there is evidence that it is strangulated, that the danger is imminent, and that the need for re-establishing the permeability of the intestine is urgent.

Do not seek further information, nor wait until the clinical picture is complete in all its details; the hernia cannot be reduced and the patient vomits: that is quite enough to demand immediate operation. It is greatly to be desired that fæcal vomiting should be excluded from the list of symptoms of strangulated hernia; fæcal vomiting is not a symptom which should ever be seen; it is simply a feature of the closing stages of a neglected case, an indication of an almost hopeless prognosis.

Nor should there be any hesitation because obstruction may at first appear to be incomplete, because the patient still passes some flatus, although the hernia is quite definitely irreducible and painful; in such circumstances remember the possibility of *lateral strangulation* and the rapid gangrene which so frequently results from it. A large hernia, umbilical for example, has been partially irreducible; it becomes absolutely so, and tense and painful; nausea and vomiting supervene, although possibly the passage of fæces and gas is not at first arrested. Disregard the old theories of hernial obstruction or inflammation; in such conditions the indication for operation is, if I may say so, even more urgent than in a typical case of strangulation. (*See* Umbilical Hernia.)

Nowadays, however, the question is definitely decided; experience has produced settled opinions; and it is no longer a question of discussing the indications for operation in strangulated or pseudo-strangulated hernias: it is **how best to render operation more widely and surely practicable in any surroundings.**

Further, the conception of hernial strangulation as a purely mechanical process, which has obtained acceptance for so long, has still too great an influence on the treatment of these cases.

There is too great a tendency to consider the strangulation as a purely

physical condition ; attention is therefore directed only to the mechanical constriction and compression exercised on the loop of bowel, and perforation or gangrene are looked upon as the great dangers. The doctrine of taxis and its applications has been founded on these ideas. In the past, attempts have been made to determine the average duration of the resistance of the intestinal wall in the different varieties of hernia, and it would be said that in such a case up to the thirty-sixth hour, in another up to the second or the third day, the chances of the bowel being still intact were good, and that taxis might therefore be applied.

The modern idea, however, the idea which should always compel us to immediate action, is different. It is not the mechanical lesion, under the constriction of the ring, which is specially to be feared and which must be placed first amongst the reasons for operating at once : **it is septic intoxication, stercoræmia.**

As soon as the fæcal circulation ceases in the strangulated, obstructed, or paralysed loop, whatever the mechanism may be, absorption begins and the patient passes under the influence of progressive intoxication. And in advance we are unable to estimate the virulence of the poison. Every hour of delay aggravates this general condition, which is more serious than the mechanical lesions of the intestine, and which may later suffice to compromise the result of a perfectly simple but too long delayed operation.

Often in urgent hospital practice I have operated on strangulated hernias dating from four, five, six, sometimes even eight days previously, and complicated by all the signs of toxæmia. One might quite naturally have expected to find serious intestinal lesions ; not so, however : the strangulation had not been very tight, there was no gangrene ; the operation was simple, and completed in very little time, but the patient succumbed a few hours later to **stercoræmic poisoning**, too deep and of too long duration to be checked by herniotomy *in extremis*.

For that reason,—because I have been the witness of such disasters, and because, on the other hand, I have cured a considerable number of strangulated hernias by early and appropriate operation, I hold that **immediate intervention is the invariable rule in all cases and in all forms.**

And what intervention ? *Herniotomy*.

I can remember the last years of the period when taxis was the classical and normal treatment, and open operation was the last resource, only undertaken when all other measures had failed ; for thirty-six or forty-eight hours I have seen attempts at manual reduction repeated again and again ; I have seen Maisonneuve's indiarubber bandage or the shot bag applied ; large so-called inflamed hernias treated by ice and opium ; and then, when everything had failed, when the patient was exhausted, collapsed, and practically dying, the sac opened at last. I cannot remember a single case of recovery after these late operations ; in those days strangulated hernia well deserved the sinister reputation which it had acquired.

At the present day, however, the rule of practice should be reversed ;

taxis ought to be only a quite exceptional method of treatment, and is in my opinion indicated only in very unusual circumstances.

The proper rule is this: **every strangulated hernia ought to be operated on at once**; and every endeavour should be made to apply the rule as widely as possible. There is no need to waste time in comparing the relative advantages of herniotomy and taxis, or in defining their applications: **learn to perform herniotomy properly and operate at once** when the need arises, and the problem of strangulated hernia will become quite simple.

Personally, my attitude has long since been settled; I have seen and treated some hundreds of strangulated hernias; I have only employed taxis on three occasions in recent strangulations: once in a very old man, and twice under conditions of time and place which were most unsuitable for immediate operation.

But, in urgent surgery it is necessary above all to refrain from laying down absolute rules; due consideration must be given to the circumstances; it cannot be denied that the problem as it presents itself to an isolated practitioner is quite different from that which arises in a hospital town. Still, I am one of those who think that every practitioner ought to be able to perform a herniotomy, and that with due care and an earnest desire to do the best for the patient, the operation can be done anywhere.

While reserving a field for the application of taxis in some special conditions, the responsibility which is assumed in applying it must not be forgotten; and in our opinion manual reduction can only be legitimately attempted in the following conditions:

1. The surgeon has been called *within a few hours of the onset of symptoms, the hernia is of moderate size, the neck is fairly wide, and the abdominal reactions are not strongly marked. If he is alone*, and if the patient is strongly averse to operation, it will be permissible to try the effect of a hot bath followed by moderate taxis, with two reservations, however: **that herniotomy shall be performed forthwith if taxis fails, and, that a radical cure shall be undertaken as soon as conveniently possible if taxis succeeds.**

A short, methodical application of taxis to an early case is scarcely dangerous; what is dangerous is taxis at a late stage, prolonged taxis, and repeated attempts deferred to the next day, or the evening, or some hours later, and which becomes more and more dangerous and less likely to produce any benefit. Manual reduction of a recent hernia is only justifiable when everything is ready for immediate operation should no success be obtained within a few minutes.

2. The patient is *very old, perhaps cachectic*, a bad subject for operation; the hernia is of old standing, and has on previous occasions given rise to trouble of the same kind, and has this time only been irreducible for a few hours.

Here again, a hot bath and taxis will be indicated; but if they fail, then, notwithstanding the age and general condition of the patient, the rule of immediate operation holds good, more decidedly even than in simpler

conditions, because in these patients toxæmia advances with such rapidity, and is so dangerous, that a delay of a few hours with an old man who might in the initial stages have borne an operation perfectly well, may involve operating under almost hopeless conditions.

Further, even within these limited indications, taxis, to be innocuous, must conform to certain rules ; and above all, **it must be short and must be methodical.**

Give chloroform or ether, if the taxis is to be efficacious and harmless, or at least, if there are no grave contra-indications, give a hypodermic injection of morphia at the level of the neck of the hernia ; place the patient in a proper position, and do not determine beforehand that the hernia must be reduced, but rather that the attempt at reduction shall be made, and if success does not follow a fair trial, then operation must be undertaken at once. Taxis does not consist in pushing the contents of the sac *en masse* through the ring ; it must be recognized—no one who has opened the sac of a strangulated hernia will deny the truth of this—that the herniated intestine, in the condition in which it lies in the sac, can never be returned directly to the abdomen by any reasonable pressure ; **it must first of all be emptied,** at least partially, and the only object of the first and important step in the performance of taxis **is the evacuation of the contents of the bowel.**

If dealing with an inguinal hernia, have the pelvis raised and the thighs flexed and separated ; then grasp the swelling as fully as possible with the right hand, the fingers on one side of it, the thumb on the other, while the fingers and thumb of the left hand are placed on guard over the ring ; no pressure from below upwards, no pushing towards the abdomen, must be exercised at first ; compress the "body" of the hernia, **widely, gently, and steadily in its whole circumference.**

If all around nothing is obtained but the sensation of a thick, compact mass, crepitating a little, which is given by omentum, carry the fingers a little higher, not far from the neck, and, as before, endeavour to exert circular compression ; it often happens that the herniated loop of intestine which is to be emptied and reduced is enveloped in a thick omental covering which fills the whole of the lower portion of the sac, and if the fingers are applied too low down, it is omentum alone which they will compress. After a very little time, within one or two minutes, it is possible to feel if the attempt at emptying the intestine is going to be successful ; the resistance is less uniform, the tension is a little less ; continue the compression, always over as wide an area of the hernia as possible and always without roughness ; *it is on the continuity of the effort rather than on its force that the result depends.*

As soon as evacuation has been started and a little of the intestinal contents has flowed back into the abdomen, usually with a gurgling noise, success is almost assured ; it only remains to complete the emptying and then to reduce the empty and collapsed loop.

It is in the latter step only that the contents of the sac are pressed upwards from below, **always by lateral pressure, never by pressure**

on the bottom of the hernia, while the fingers of the left hand, placed over the neck, compel the successive segments of the intestine to pass regularly through the opening, without doubling on themselves, or overlapping and so closing the channel.

As soon as the intestine has passed back through the inguinal canal, a fresh effort is required to reduce the omentum, and if the mass is large and thickened, fused into a compact lump or adherent, it is certainly much better to renounce complete reduction rather than run the risk of lacerations and hæmorrhage, which are the more serious in that they are at first unperceived.

Femoral and *umbilical* herniæ are less well adapted for methodical taxis; but here again, **the evacuation of the contents of the bowel** must be the first step, and **reduction** proper the second.

The hernial swelling must first of all be compressed methodically over its whole periphery; direct pressure should never be applied to the fundus. Fairly often, in small hernias, after a few minutes' compression, the intestine will be felt suddenly to slip away under the fingers; not uncommonly, when the sac is enveloped in fat or lined with adherent omentum, a quite evident thickening will persist and give rise to doubts as to the completeness of reduction.[1]

We cannot just now mention **the mishaps which may be associated with taxis**, but we shall consider them later on when dealing with the operative measures which they may render necessary. (*See* HERNIA COMPLICATED OR ALTERED BY PREVIOUS TAXIS.)

To sum up: as a preliminary measure or as a method of necessity, and if carried out with the precautions and in the manner which we have just described, taxis is in itself not dangerous, but it may become so *by causing loss of time.*

[1] Here let us mention the curious influence sometimes exerted by ascites, particularly acute ascites, in the production of hernial symptoms, and the unexpectedly successful result which often attends abdominal paracentesis in such cases. A man some sixty years of age was brought into my hospital service with very definite signs of a strangulated right inguinal hernia; he was vomiting, and had passed neither fæcal matter nor flatus for two days: the hernia was very large, very painful, tense and smooth, contained a considerable quantity of fluid, and was quite irreducible; the abdomen was greatly enlarged and quite evidently filled with free fluid, which had been present for a long time, but had increased considerably during the last few days. I adopted the plan of first puncturing the abdomen on the left side, and withdrew about 10 or 11 pints of clear, yellow fluid, after which, by gentle taxis, I reduced the hernia without trouble and emptied the sac of its solid and fluid contents. The patient, who had for a long time suffered with ascites due to hepatic cirrhosis, had on several occasions during temporary sudden increase in the quantity of fluid, seen his rupture become irreducible and painful; but the symptoms had never been so severe as to indicate actual strangulation. Several similar cases have been published, and it is well to keep them in mind and, at any rate in cases of strangulated hernia associated with very severe ascites, to aspirate the abdomen first of all, to relieve tension, and to determine if it may not be possible easily to relieve the condition by taxis.

In quite young children, these pseudo-strangulations due to peritoneal serous effusions of indefinite origin, of sudden onset and short duration, are, as M. Lucas-Championnière has shown, not uncommon: he has also shown that by the method of inversion, taking the child by the feet and holding it for a few minutes head downwards, the sac can easily be emptied and the hernia restored to the abdomen; in very young infants true strangulation is rare, and this simple procedure is always worthy a trial.

SIMPLE STRANGULATED INGUINAL HERNIA.

This is the typical case for the operation of **herniotomy.** Every step in an operation for strangulated hernia ought to be carried out under visual guidance; we no longer say: Open the sac cautiously in the scrotal portion, introduce the finger for the purpose of determining the position and characters of the neck, and along it insinuate a special probe-pointed knife and divide the constriction—without seeing it—on this side or the other (upwards and outwards usually) to the depth of some small fraction of an inch.

No: the division of the constricting ring is no longer made blindly with the finger as the only guide; the wall of the inguinal canal and the sac are freely incised, *so that everything that is done may be seen*, and at one stroke all the old discussions as to the exact nature of the constricting agent, all the special technicalities devised for the purpose of avoiding vascular dangers, are relegated to a secondary position, and, what is of even greater importance, the way is cleared for completing the operation of necessity by a radical cure.

THE OPERATION OF HERNIOTOMY.

Let us presume that **we have to deal with an ordinary inguinal hernia, containing intestine and omentum, recently strangulated and without any abnormality or complication.** As a rule, the patient should be anæsthetized with ether or chloroform. Local anæsthesia, by means of cocaine or stovaine, is very valuable if the operator is alone, or if the patient is old and feeble; after the operation area has been carefully prepared, 2 or 3 drachms of a $\frac{1}{2}$ per cent solution are injected along the line of the proposed incision. The injections must be made into the thickness of the skin, endermically; the appearance of a whitish wheal will indicate that the solution has been injected into the proper plane; another drachm of the solution is now injected into the subcutaneous tissue, and the syringe and solution are kept at hand, to repeat the injections, if necessary, into the deep tissues, the aponeurosis, and around the sac. The whole region, scrotum and pubes, has been shaved, washed with soap and water, bathed with spirit, ether, and boiled salt solution; do not forget to carefully cleanse the penis, the glans, and the prepuce. A piece of gauze is wrapped round the penis and secured by a pressure forceps, and the operation area is surrounded in the usual way with sterile towels.

1*st step.*—**Incision and Exposure of the Sac.**—The **Incision** will follow the long axis of the hernial swelling; it will be long, descending to the lower third of the scrotum (if dealing with a scrotal hernia), and, most important, **its upper extremity must extend to beyond the middle of Poupart's ligament.**

The latter point is of the utmost importance if the constriction is to be relieved under the guidance of the eyes; **it is not the scrotal but the inguinal portion of the hernia which must be attacked first.** Divide the skin and subcutaneous tissues with long, steady cuts down to the *white, fibrous surface* of the external oblique aponeurosis, which constitutes the first rallying-point (*Fig.* 116). In the subcutaneous fat some vessels will be met with—the superficial epigastric and its branches, which cross Poupart's ligament and run obliquely towards the umbilicus; there are usually two, sometimes three, small vessels, comprising an artery and two veins, often of some size; divide each of them between two forceps, or simply cut them and then catch the bleeding points; the whole step is perfectly simple, and need cause no delay.

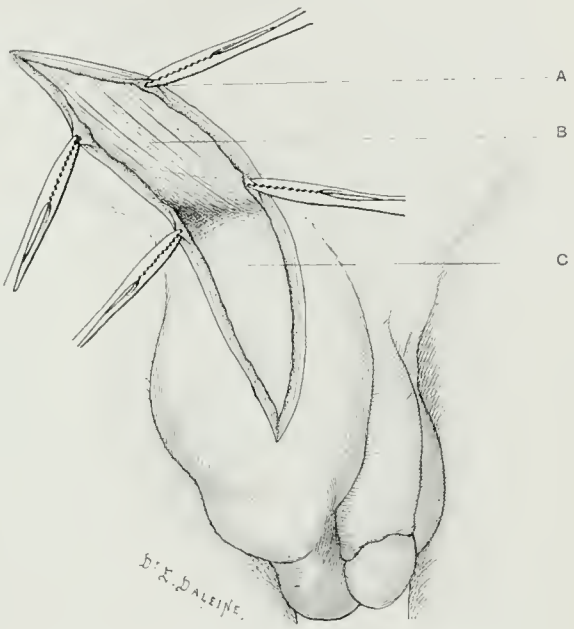


Fig. 116.—Inguinal herniotomy. 1st step: Incision. (A) Forceps applied to the subcutaneous vessels. (B) Aponeurosis of the external oblique. (C) Wall of the sac.

2nd step.—**Opening the Sac.**—The aponeurosis is exposed, and below it, the outer surface of the sac—more or less tense, greyish or purple in colour—is visible. Incise the aponeurosis to the upper limit of the sac, cutting carefully the arching intercolumnar fibres at the margin of the external ring (*Fig.* 117). With some deftness of hand the section can be quite well executed directly; the two aponeurotic flaps are at once secured with forceps, and free access to the neck of the sac is secured.

The aponeurosis may also be incised, and perhaps more safely, in the following manner: with the grooved director separate the outer pillar of the external ring which encircles and constricts the neck of the sac, slip the director below it, between it and the sac, and on the director divide the aponeurosis with scissors out to the external angle of the cutaneous wound.

If the hernial pedicle is much distended, and the aponeurosis too much stretched and too intimately fused with the wall of the sac to permit of it being incised separately, then the sac must first of all be opened in its scrotal portion, in the manner which we shall describe immediately; a finger is

introduced through the opening and passed up to the neck, and on it as a guard the two layers, sac and aponeurosis, can be divided with safety.

Whether it is practised primarily, or after preliminary incision of the external oblique aponeurosis and of the fibrous tissues around the neck, **the opening of the sac** demands the utmost care; the strangulated bowel often completely fills the cavity, and is in intimate contact with the serous coat; sometimes it is adherent and very likely to be wounded, or at any rate lacerated, by the knife or the point of the scissors; moreover, the sac wall is sometimes very thick, covered with fat, and its deep layers may be blackish in colour and infiltrated.

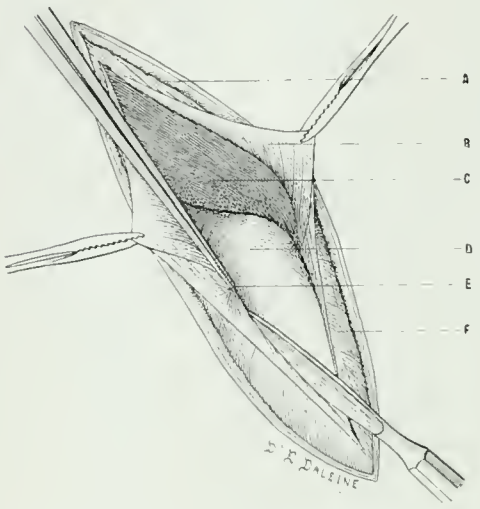


Fig. 117.—Inguinal herniotomy. 1st step: Incision of the aponeurosis of the external oblique; exposure of the sac. (A) Subcutaneous tissue. (B) Aponeurosis of the external oblique, divided and secured with forceps. (C) Internal oblique muscle. (D) Wall of the sac. (E) Outer lip of the fibrous covering, raised by dissecting forceps and being dissected up with the scalpel. (F) Inner edge of the fibrous covering.

It has been said—and the statement is always worth repeating—that **so long as any doubt exists, it may be considered as certain that the sac has not been opened.** Practically, however, it would be a mistake to enlarge too much on the difficulties of this step, which can always be carried out satisfactorily if proper care is exercised.

It is a good plan to divide the outer layers of the sac on the grooved director, of course without attempting to define exact anatomical planes. If preliminary section of the aponeurosis has been practised, slip the director from below upwards, under the outer fibrous layer, and cut it, repeating the performance on the next layer. When nothing more can be picked up easily with the director, take the dissecting forceps and the scissors, raise up a small fold of the sac wall with the forceps, make sure that the fold is free from the underlying structures, then open it with the points of the scissors held almost parallel to the surface of the sac (*Fig.* 118).

This step is always, in one's earlier operations, a source of some anxiety; rest assured, however, that if the foregoing technique is closely followed there is no danger; but it would be dangerous to attempt to incise the sac directly, perpendicularly to its surface, with a scalpel, which either cuts too deeply or not deep enough; or again, to try to open the sac by thrusting the point of the scissors through the wall. If a fold is picked up and opened, parallel to the surface of the sac, there is no fear of doing any damage.

Therefore, do not waste time timidly scratching through the sac wall; one may feel quite sure that as soon as the cavity has been opened into, the fact will be rendered evident, sometimes by a jet of reddish fluid, always by the appearance of a smooth, free, serous surface which cannot be mistaken.

Enlarge the little opening sufficiently to allow the introduction of the index finger, and on it divide the sac wall, first of all to the level of the ring (*Fig.* 119), and then downwards to the fundus. Remember that we are speaking just now of a simple hernia without adhesions; subsequently we shall see what must be done under other conditions.

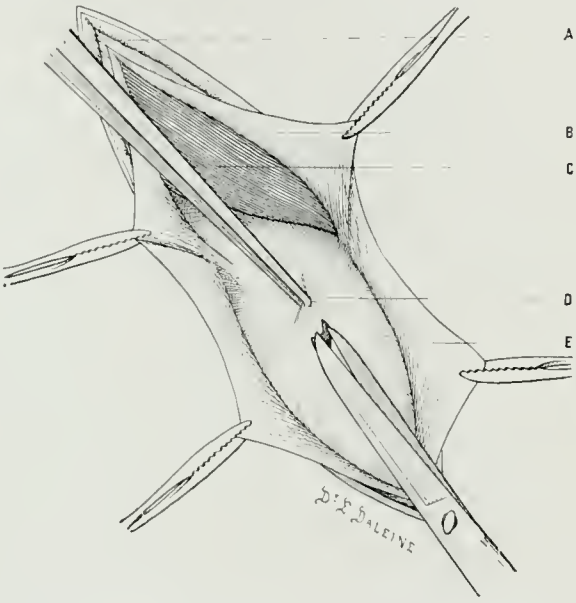


Fig. 118.—Inguinal herniotomy. 2nd step: Opening the sac. (A) Subcutaneous tissue. (B) Aponeurosis of the external oblique, divided and secured by forceps. (C) Internal oblique. (D) Anterior wall of the sac, raised into a fold with forceps, while the base of the fold is being opened with scissors. (E) Fibrous covering.

Secure the two edges of the sac wall at once with some pressure-forceps and, before going any further, *cleanse the contents of the sac*—an excellent precaution, the need for which was originally pointed out by Verneuil,—sponge the intestine and omentum gently with warm boiled water, and cover them up with a sterile compress.

3rd step.—**Relieving the Constriction.**—The neck of the sac has already been partially liberated by the division of the external oblique aponeurosis; examine it with the index finger; it will very seldom happen that, while depressing the pedicle of the hernia with the pulp of the finger, the tip cannot be passed through by a moderate effort; then divide the constriction with the scissors on the finger (*Fig.* 119 and *Plate IV*).

If the constriction is very tight, one will at least be able to raise it sufficiently to allow the blunt point of the scissors to be insinuated underneath without risk, and to nick the lower edge of the stricture. In this way some relaxation will be obtained, and the scissors can be passed a little further, dividing the tissues bit by bit until the obstruction is overcome; the manœuvre may be facilitated by the use of a grooved director. Lastly, there are some constrictions, very tight and situated deeply, in which the probe-pointed hernia knife is still the best instrument.

Divide the whole of the contracted neck of the sac freely in its vertical extent, but guard against extending the incision unnecessarily on the abdominal side, and *try to preserve a pedicle* to which a ligature may afterwards be applied. I need scarcely add that it is essential to secure the two edges with forceps as soon as the incision is made.

The position and possible multiplicity of the strangulating bands demand attention, since it is necessary to make sure that the constriction has been completely relieved. The rule is very definite; sufficient relaxation must be obtained to allow of the intestine and omentum being easily drawn down, so that a thorough examination may be made, not only of the constricted portion, but also of the segment above. So long as this is impossible the constriction is insufficiently relieved.

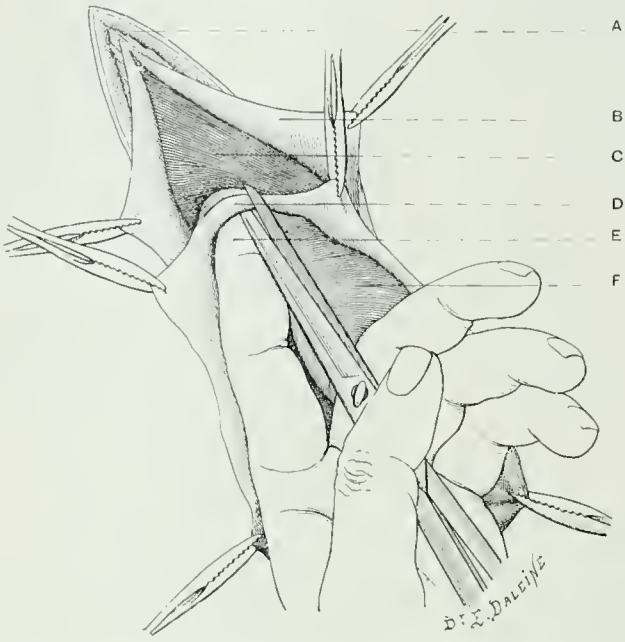


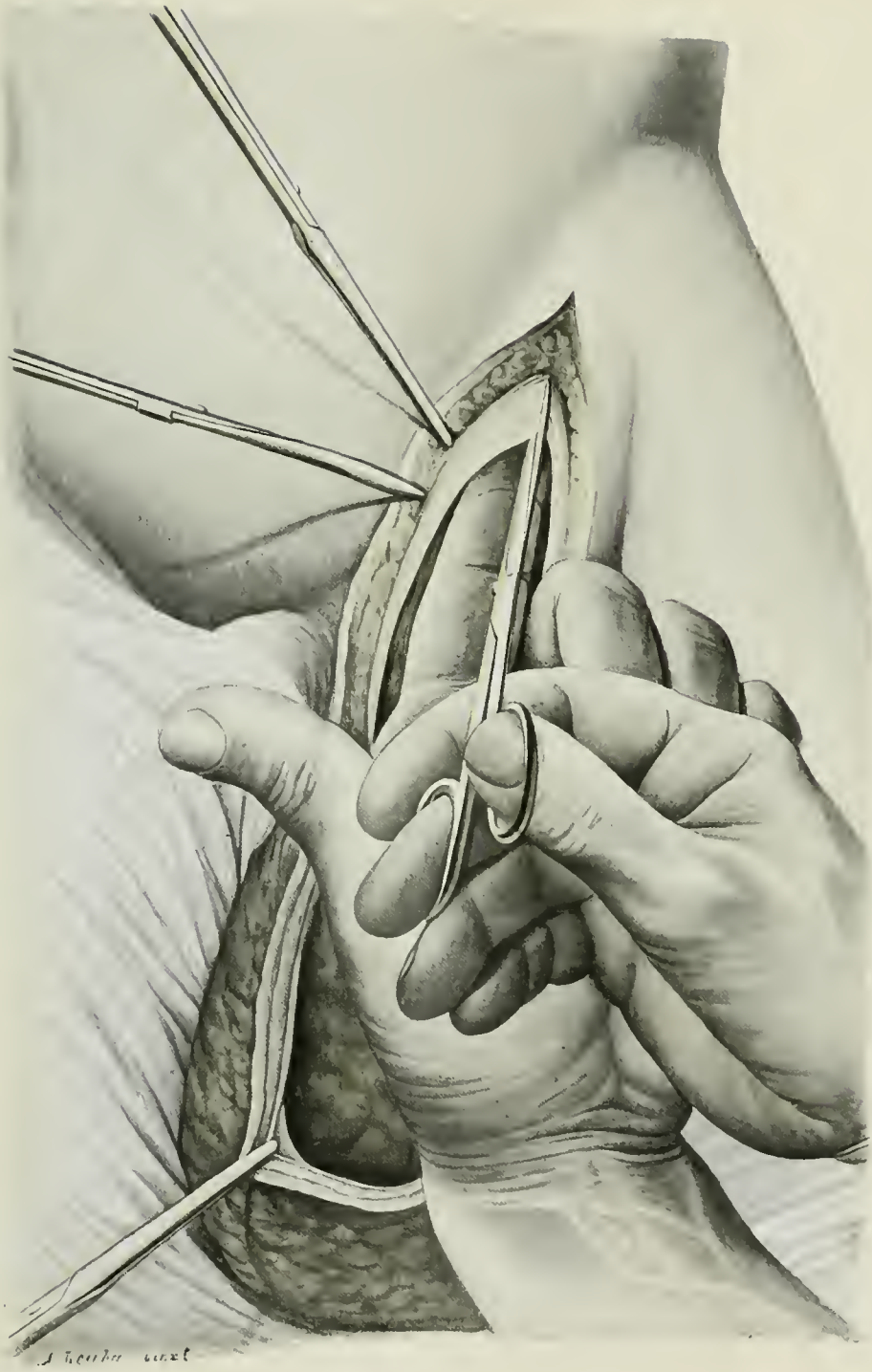
Fig. 119.—Inguinal herniotomy. 3rd step: Dividing the neck of the sac. (A) Subcutaneous tissue. (B) Aponeurosis of the external oblique, divided and secured with forceps. (C) Internal oblique muscle. (D) Neck of the sac. (E) Left index finger, insinuated below and lifting up the neck of the sac in front of the scissors, with which it is being divided. (F) Herniated intestine.

In congenital herniæ, the zones of constriction may be *multiple*, situated at various points along the track of the hernia; it may be necessary to divide one, two, or three bands, often very dense and tight, and it is very important to carry the search for a deep constriction *very high up, to the internal ring*, and even beyond it.

I have seen these congenital hernias, with the neck of the sac situated above the inguinal region, operated on, and at one time operated on them myself by the old method of blind division of the constriction with Cooper's hernia knife, and I can well remember the great difficulties which were always met with.

The technique of the operation is remarkably simplified by the free incision which we have just described; *step by step, as the sac is incised*,

Plate IV.—Inguinal Herniotomy. Division with scissors upon the finger.



INGUINAL HERNIOTOMY

its deep portion is pulled down into view by the forceps, which grasp the cut edges, and there is no difficulty in exposing and dividing a constriction situated in the internal inguinal or supra-inguinal regions.

As I said a moment ago, the operator must not be satisfied until the intestine descends with perfect freedom ; pass the finger through the orifice, which has just been enlarged, into the abdominal cavity, and make sure that there is no further obstacle, no constriction, no tense band.

4th step.—**Examination of the Contents of the Sac ; Resection of the Omentum.**—The omentum and intestine are gently drawn down

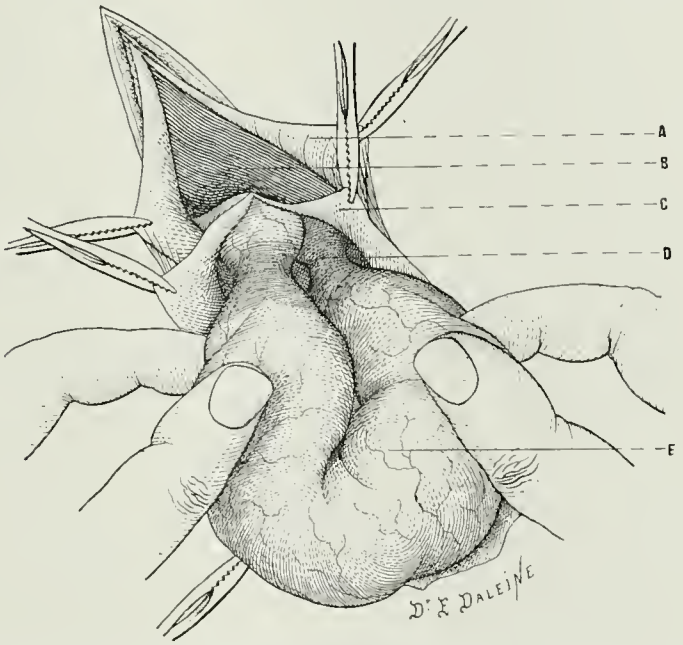


Fig. 120.—Inguinal herniotomy. 4th step The intestine is drawn down and examined. (A) Aponeurosis. (B) Internal oblique. (C) Neck of the sac, freely incised. (D) The constricted portion of the bowel. (E) Middle portion of the herniated loop.

(*Fig.* 120), and a minute examination is made to determine their condition and the necessary line of action.

Assuming that their condition is satisfactory—which is equivalent to saying that the omentum will often be thickened and infiltrated, gathered into a compact mass, and marked at the pedicle by a deep groove ; but its colour is practically normal, only slightly redder ; it crepitates under the fingers, it is only folded on itself, without adhesions between the folds, there are no patches or shreds of yellow lymph. I shall say presently what should in my opinion be done with the omentum in all cases.

The intestine at the point of constriction bears a circular groove, usually very marked (D, *Fig.* 120). The groove is more distinct on one of the limbs.

generally the posterior, and also more distinct on one side of the limb, that which corresponds directly to the constricting agent. Examine the groove very carefully after cleansing it with a sterile compress; see if the serous coat is intact, if the general dusky, purplish colour is not varied, at some points, by brownish, greyish, lustreless patches. The loop beyond the constricted portion is blackish, and its first appearance when the sac is opened is always somewhat alarming. Subject the entire surface to close inspection, look for some flaccid, lustreless, greyish plaque which may indicate a lesion more serious than mere vascular stasis; note particularly how it reacts when the strangulation has been relieved and after bathing with warm boiled water.

After a few minutes, if the process has not passed beyond the limits of spontaneous repair, the intestinal wall recovers its tonicity, the colour becomes brighter, and it is manifest that the circulation is restored. If so the intestine may then be reduced.

Sometimes **partial lesions** will be found, a little more advanced, which will not, however, prevent reduction after some minor preliminary reparative measures.

I refer to *lesions of the serous coat*, which may be fissured, stripped up, peeled off, sometimes over a considerable area, laying bare the underlying muscular coat, which is, however, healthy and of good colour; also to certain *lacerations* in the vicinity of the neck or on the length of the loop (due, only too often, to rough attempts at reduction by taxis) *involving both serous and muscular coats*, and at the bottom of which the outer surface of the mucous membrane can be seen; and lastly to *lacerations of the mesentery*, fissures sometimes of considerable length, or irregular bleeding tears close to the intestinal attachment.

All these conditions are reparable if due care is exercised, but all doubtful places must be restored before reduction.

Fissures of the serous coat will be closed, and small, partially separated flaps replaced and fixed in position by a few interrupted sutures or a continuous suture of fine catgut; if the injury implicates the wall deeply, a Lembert suture will be necessary. It is always bad practice to restore a loop of intestine, partly stripped of its serous covering, to the abdominal cavity unrepaired, even though the bare area is but of small extent; although perforation is very improbable, these denuded surfaces inevitably contract adhesions and may give rise to acute angulation, bands, and serious subsequent functional troubles.

Therefore, if the serous coat is destroyed at any point, the small denuded surface must be infolded by a Lembert suture. It is equally important to close any mesenteric fissures, exercising due care to avoid injury to the vessels in the vicinity.

Bleeding mesenteric lacerations are always difficult to repair: forceps, if badly applied, tear off and simply enlarge the lesion; by careful sponging it will be possible to see the bleeding vessel and to seize it directly; the best plan, then, is to pass a ligature around the vessel a little beyond the bleeding point, including as little as possible of the mesenteric

tissue, and to tie it very cautiously ; one or two Lembert sutures at the mesenteric insertion are sometimes required to complete hæmostasis.

Everything is now ready for reduction. Compress the herniated loop gently, especially the posterior limb, which is usually the first to emerge, and is as a general rule the more convenient to return first ; the loop partly empties itself under the pressure of the fingers, and the reposition of one of the limbs (the posterior, as we have just said) is begun and continued bit by bit, while the other hand controls the second limb, and prevents any more from emerging.

When the loop of intestine is very long, this methodical reduction is even more essential ; it is to be kept in mind that intestine which has just undergone more or less prolonged vascular stasis is in a condition of impaired physical resistance, and that rough handling may readily produce the lacerations and separations of the serous covering of which we have already spoken, and perhaps even more serious injuries.

What is to be done with the omentum ? Certain hernias, even very large ones, contain no omentum. If there is a little—a few fringes—this may be reduced after careful cleansing ; even a large mass of omentum may be reduced if it has preserved the characters already mentioned, if it is not inflamed and its folds can be separated, or if, for any special reasons, excision seems inadvisable ; but as a rule, *herniated omentum ought to be ligated and resected.*

The ligatures must be applied in healthy tissue, after a sufficiently long and perfectly free intra-abdominal segment has been drawn out ; very often deep adhesions will be found at or above the neck, which, if unrecognized, would retain the omentum fixed to the inguinal wall ; further, the omentum may have undergone " torsion " within the abdomen above the internal ring.

Resection is the safest plan from the standpoint of the immediate prognosis, because all risk of peritoneal infection from diseased omentum is thereby prevented ; further, it is a guarantee for the future, because these large prolapsed masses of omentum after reduction often remain in contact with the inguinal wall, contract adhesions there, and are very likely to give rise to recurrences.

Omental resection is not a task to be undertaken carelessly ; I have seen two fatal cases in which badly-applied omental ligatures were the sole cause of death ; the ligature had slipped, and nothing bleeds like a large stump of omentum free in the peritoneal cavity.

Never trust to a simple ligature, even on a comparatively thin strip of omentum ; security (apparent) can only be obtained by extreme constriction, and the friable fatty tissue will cut under the thread, or tear at some point above the knot, and the tear, at first small and unnoticed, will always in the end become larger.

A ligature of the omentum ought always to be an interlocking ligature.—If the segment is of moderate size, two entwined threads, or Lawson Tait's ligature, will answer perfectly. Through the centre of the bridge of tissue to be tied, with a ligature needle (*Fig.* 124)

or with ordinary pressure forceps, pass a double thread or a loop; the latter, after having been passed, will be divided in the middle; cross the two threads and tie them firmly and steadily on either side with a surgeon's knot.

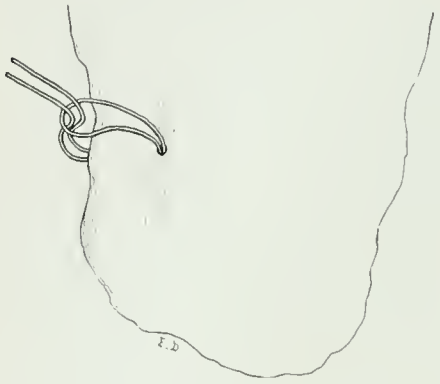


Fig. 121.—Ligature of the omentum. Lawson Tait's ligature (1st step).

With a little practice, Lawson Tait's ligature is very easily applied; personally I have used it for a long time for most pedicles. A loop is passed through the centre of the segment to be ligated, the two free ends are brought round to the front, passed through the loop and drawn tight, so forming the first "running half-knot" (*Fig.* 121); one of the ends is then carried in front, the other behind, around the second moiety of the pedicle, drawn well tight, and secured by a double knot. *Figs.* 121 and 122 will convey a better idea of the ligature than any verbal description.

When the mass of omentum is of larger size, it will be necessary to use several interlocking ligatures. It will sometimes be convenient to tie the omentum in two portions with two Lawson Tait ligatures; the first loop is passed through at a suitable distance from one of the borders, the right for instance; the two ends are slipped through the loop, one of them is retained in front, the other is carried round behind and brought through at the centre of the breadth of the mass of omentum with a pedicle needle or Reverdin's needle, to the front, where it is knotted with the former end.

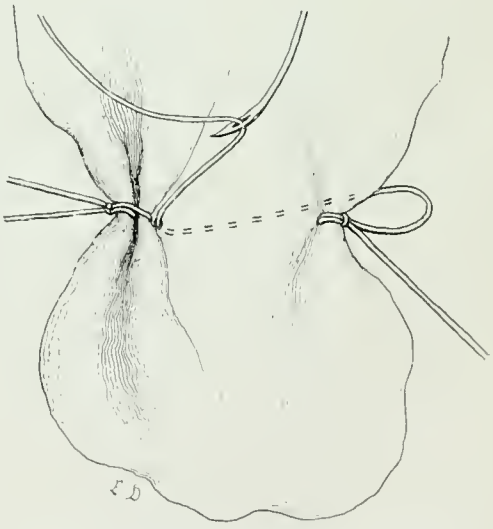


Fig. 122.—Tying off the omentum with a double Lawson Tait ligature. On the left side the ligature is completed; on the right it is in process of execution.

The right half of the omental segment is thus secured by the first Lawson Tait ligature; the manœuvre is repeated on the left side and, as before, the posterior end of the second ligature is brought through the centre of the mass of omentum by the same orifice to the front, and the ligature completed (*Fig.* 122).

In this manner great security is obtained, and as an additional safeguard, once the two ligatures have been completed, two of the ends may be knotted together in front (*Fig.* 123), the others behind.

But it is impossible to tie a very large mass of omentum in two portions only; the stump would be too large, reduction would sometimes be impossible, and further, the constriction of a very thick pedicle is never perfect.

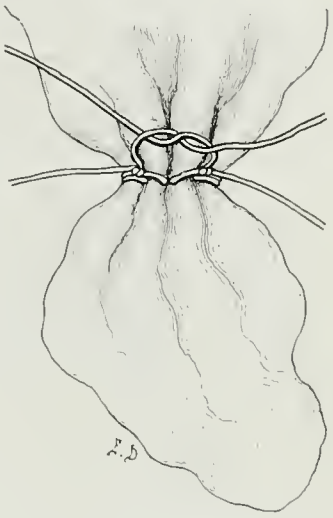


Fig. 123.—Tying off the omentum with a double Lawson Tait ligature. The two ligatures are completed; for additional security the two anterior ends are being tied together.

In such a case, proceed methodically in the following way; have the sheet of omentum raised up and spread out in front of you: take a very long thread of catgut or silk and lay it along one of the surfaces, on the anterior for example; perforate the omentum half an inch from its right border with a ligature needle or forceps, seize the common thread and draw a loop of it through to the posterior surface; the loop must be sufficiently long to enable the corresponding segment to be ligated comfortably afterwards. At the same distance beyond the first loop, the omentum is perforated again, and a second loop brought through, and so on till a sufficient number of loops have been passed. Naturally each of these loops is secured with forceps (*Fig.* 125).

When this first part of the work has been properly carried out, the rest becomes very simple and can be readily understood; loop No. 1 is cut at the middle the right end is left held in the forceps, the left end is taken, crossed with its neighbour, and then tied on the left border of the omentum with the initial end of the common thread, thus forming the first ligature; loop No. 2 is dealt with in the same manner; it is cut, the

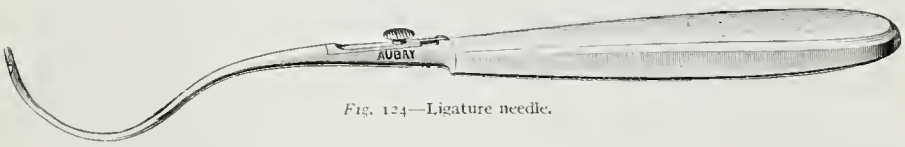


Fig. 124.—Ligature needle.

left end is crossed with the right end, which remains in the grasp of the forceps; it is then knotted with the remaining end of the first loop; and so with the others (*Fig.* 126).

We must repeat that this interlocking ligature requires care and method for its proper execution; still, if the forceps which secure the loops are conveniently arranged, it can be carried out quickly and well. Good

ligature material is indispensable : catgut or silk of medium thickness and proved strength.

The omentum will be cut with scissors at about a third of an inch below the line of ligature ; the stump, carefully wiped with a gauze swab, ought to be perfectly dry ; the ends of the ligatures will be cut a quarter of an inch from the knots, and then nothing remains but to reduce the stump. When the stump is rather thick, reduction demands some care ; the omentum must never be forced through the ring ; to do so would be to incur the risk of lacerating or tearing the membrane or of causing the ligatures to slip ; the proper plan is to provide a larger opening by carrying the incision in the ring a little further, and to separate the margins of the opening widely with retractors ; or again, it may be possible to effect reduction without further incision by insinuating one of the angles of the stump obliquely through the ring ; if the attempt succeeds the rest will follow without difficulty.

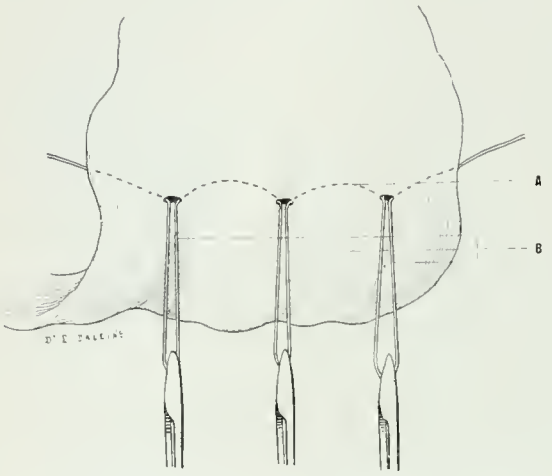


Fig. 125.—Tying off the omentum with a series of interlocking ligatures. The omentum is held up. Passing the loops of the common ligature. (A) The common ligature. (B) Loops of the common ligature, traversing the omentum at regular intervals and secured with forceps.

The reduction of the omentum constitutes the last intrasaccular manœuvre ; when it is completed the mind of the operator should be free from any doubt ; he should feel quite certain that the intestine is in a healthy condition or that it has been properly repaired, and that the omentum has been securely ligated. A gauze plug, secured by forceps,

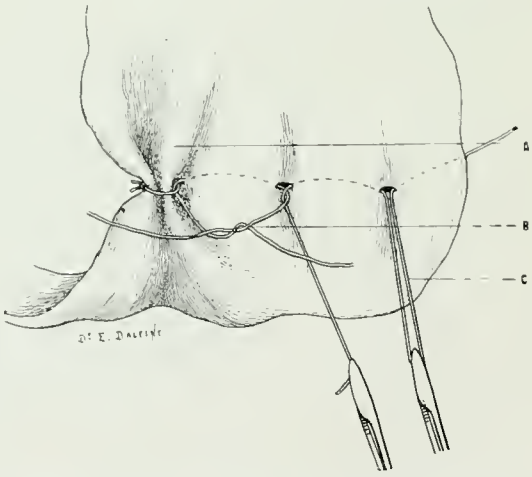


Fig. 126.—Tying off the omentum with a series of interlocking ligatures. Crossing and tying the ligatures. (A) Segment of omentum already tied. (B) Ligating the second segment. (C) A loop still undivided.

is placed in the ring (D, *Fig.* 127) to retain the intestines during the execution of the next step.

5th step.— **Separation, Ligature, and Excision of the Sac.**—Begin the separation in the inguinal canal at the neck of the sac, and continue it from above downwards ; remember that, apart from certain anomalies, the cord is usually situated below and behind, that its elements are generally dissociated and spread over the external surface of the sac, that the vas deferens is sometimes, and particularly in congenital hernias, closely associated with the serous lining, embedded to a certain extent in the outer layers, and covered and hidden by a delicate whitish membrane.

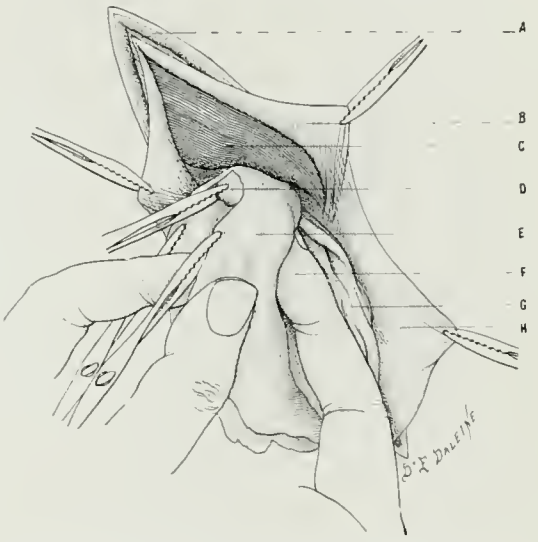


Fig. 127.—Inguinal herniotomy. 5th step : Separation of the sac. A, B, C, as in *Fig.* 120. (D) Gauze plug, secured with forceps, occluding the neck of the sac. (E) Wall of the sac. (F) The finger separating the sac wall. (G) The cord. (H) Fibrous covering of the sac.

Raise up one of the two edges of the opened sac by means of the fixation forceps which have been applied to it, and separate it carefully with the tip of the finger or with a director, or, better still, with a piece of gauze ; look for the cord, and disengage it gradually until the deep aspect of the sac is reached ; then repeat the same process on the other side, thus effecting complete circular separation of the neck of the sac (*Fig.* 127).

If the separation is easy, pass down at once to the scrotal portion and isolate the entire sac, raise it up, and proceed to ligate the neck **as high up as possible.** This is not a superfluous instruction, for the success of the radical cure depends to a great extent on the way in which it is carried out. The pedicle of the sac must be freed in front and behind, and at the same time drawn downwards until *the extraperitoneal fat comes definitely into view.*

The appearance of a large mass of fat to the inner side of the neck, particularly in large old-standing hernias complicated by considerable weakening of the abdominal wall, must always be regarded with suspicion ; as we shall have occasion to mention later, the bladder is often hidden in such a mass of fat ; great caution must be exercised in drawing the latter outwards, and the ligature must not be tightened until the fat has been pushed back and it is certain that the sac alone is included.

Some modification is necessary when the sac is very adherent and when, in congenital hernias, it is continuous with the tunica vaginalis.

In either case, the neck is first of all isolated in its entire circumference, separated to a sufficient height, and then at once ligated; the sac is divided below the ligature and the dissection continued from above downwards.

In the case of a peritoneo-vaginal sac, the excess is resected, and sufficient retained at the lower end to form a tunica vaginalis, the opening in which will be closed by a continuous suture of fine catgut.

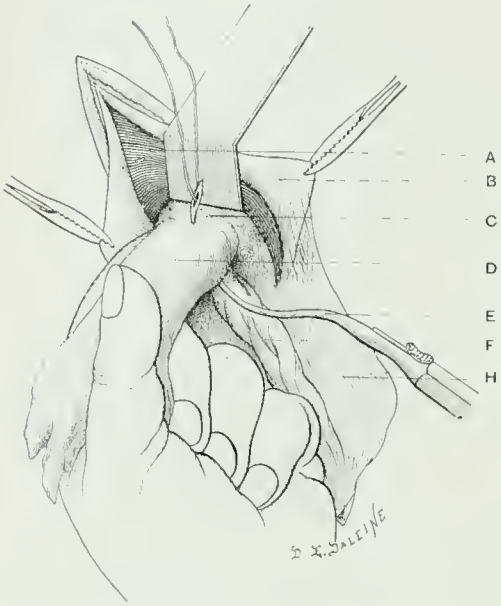


Fig. 128.—Inguinal herniotomy. 5th step: Ligating the neck of the sac. (A) Internal oblique. (B) Aponeurosis of the external oblique. (C) Neck of the sac, isolated very high up, to the extraperitoneal fat, and perforated by a Reverdin needle carrying the ligature. (D) Sac. (E) Reverdin needle. (F) Cord. (H) Fibrous covering of the sac.

If the attachment of the deep layer is very close, there is no reason why a strip should not be left in front of the cord, so long as the neck is properly isolated and tied. In such circumstances we have employed the following plan: at about the middle of the length of the sac the two lateral edges were incised transversely out to the part that was adherent to the cord. The incision was then carefully carried, still transversely, across the front of the cord from within the sac; it was then possible to separate the adherent lamella from the cord by dissection from below upwards as far as the ring, the less adherent lateral portions being separated step by step as the dissection advanced. With care, and by taking time (the object is worth the trouble), it will be possible in this way to free the neck sufficiently to allow of a ligature being applied in a good position. The remaining portion of the sac will in its turn be separated by dissection from above downwards, in order to restore the testicular covering.

In these cases the sac wall is often very thin and easily torn; sometimes, indeed, ligature of the neck is impracticable; we shall see presently what methods must be adopted to secure the indispensable occlusion of the sac in such circumstances.

The ligature of the neck is as a rule effected by means of a double interlocked thread: in other words, the neck is perforated at as high a level as possible with a ligature needle or with a Reverdin needle; a loop of the ligature material is drawn through (*Fig.* 128) and tied in a Lawson Tait

knot (see above), or the loop is simply cut and the two perforating ends crossed and knotted on either side of the pedicle.

Few things are more disturbing than to see a badly-tied sac slip away from the ligature and open up afresh, while the intestines reappear in the opening. If such an accident occurs, it is absolutely necessary to seek for the serous edges by retracting, and if necessary incising, the bottom of the wound, to secure them with forceps, and, by drawing them down, to reconstitute the stump of the sac and apply another and better ligature to it.

When the orifice is too large and the neck incised too high up to allow of a fresh pedicle being formed, the difficulty may be overcome by the following method, which is also applicable to those cases (congenital hernias in particular) where a troublesome separation of the upper segment of the sac and lacerations of the neck leave an insufficiency of tissue for the application of a circular ligature ; the two edges, anterior and posterior, of the opening in the serous membrane will be secured and made taut by four forceps, and then united by a sufficient number of interrupted sutures. This is, however, only a method of necessity, and should never be employed if it is at all possible to form a proper pedicle.

When the sac has been tied at the neck and the lower part resected, the essential part of the operation is finished ; and if time presses, and if the condition of the patient demands haste, it may be rapidly completed by uniting the two edges of the cut external oblique aponeurosis, and partially closing the external ring by means of a continuous suture, and then suturing the skin wound.

As a rule, however—the possibility is another advantage of the early herniotomy—a complete radical operation ought to be performed, which, so to speak, makes the patient the better for his accident, by protecting him from a recurrence.

6th step.—**Radical Cure.** The following procedure, a combination of several methods, is easily carried out and gives excellent results, *if the abdominal wall is in good condition*, a reservation which applies to all methods ; it consists in reconstructing, first the posterior wall, then the anterior wall, of the canal.

Before dealing with the walls, it may be useful in certain cases where the neck of the sac does not seem to have been ligatured at a sufficiently high level, to adopt Barker's method of obliterating any vestige of a peritoneal process at the site of the internal ring by displacing the stump of the sac and fixing it to the deep surface of the wall (*Fig.* 129). The two ends of the ligature closing the neck of the sac are left long ; the left index finger is insinuated under the lower edge of the internal oblique and transversalis muscles, and directed upwards and inwards for a little distance behind them ; a blunt ligature needle is passed through the muscles from without inwards down to the finger, by which it is guided to the bottom of the inguinal wound, where one of the ends of the ligature is passed through the eye ; the needle is then withdrawn and brings the thread with

it (*Fig.* 129). The procedure is repeated, the needle being again passed through the wall a little to the inner side of the first point of penetration and the second end drawn through ; the two ends are then knotted together (B, *Fig.* 131) on the surface of the aponeurosis of the external oblique ; the stump of the sac is in this way pulled upwards, and applied to the deep surface of the musculo-aponeurotic abdominal wall above the inguinal canal.

This procedure is as a rule unnecessary if the sac has been properly separated and ligatured, and further, it is attended by some risk of damaging the parietal vessels (the deep epigastric and its branches) ; personally we have entirely abandoned it. It is to the restoration of the walls of the canal that attention must be chiefly directed.

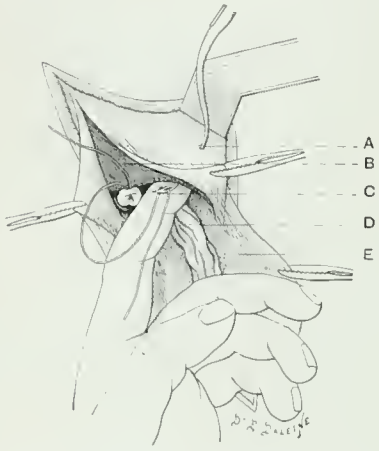


Fig. 130.—Inguinal herniotomy. 6th step : Displacing the neck of the sac under the abdominal wall (Barker). (A) Curved needle perforating the abdominal wall from above downwards and from within outwards to pick up the ends of the ligature which has been used to tie the neck of the sac. (B) Internal oblique muscle. (C) Neck of the sac, tied. (D) Cord. (E) Fibrous covering of the sac.

Turn down the lower edge of the incision in the external oblique aponeurosis, make it tense by pulling on the forceps which were placed on it in the initial stages of the operation, and it will be seen that the deep surface of the aponeurosis is curved like a gutter, and terminates on the posterior wall a short distance above Poupart's ligament in a very definite pearly-white ridge which stands out prominently from the greyish background formed by the fascia transversalis, and extends obliquely inwards to the pubic spine (E, *Fig.* 131).

This ridge is *the posterior border of the inguinal gutter*, and to it must be sutured the arching lower border of the transversalis and internal oblique muscles (D, *Fig.* 131) which lies under the upper lip of the wound, and the common fibrous expansion (the conjoint tendon) which continues the muscles inwards to the linea alba and the pubic crest.

If the cord is neither very thick nor laden with fat, it may quite well be left at the bottom of the inguinal gutter, and the two walls of the canal sutured in front of it, a very strong and resistant double outer wall being thus formed (*Fig.* 130).

If otherwise, raise the cord and draw it aside with a retractor or a strip of gauze, and then proceed to restore the posterior wall of the canal ; pick up the retro-inguinal fibrous ridge with the dissecting forceps and pass a curved Reverdin needle through it close to its pubic attachment and through the flat tendon of the internal oblique and transversalis muscles above, and draw through the first loop of catgut or silk, which, when knotted, will form the starting-point of the continuous suture.

Continue the suture from within outwards, including in each stitch the fibrous ridge below, and the lower border of the muscles above (*Fig.* 131); tighten each stitch carefully, and take a good hold of the muscle border, which ought to be drawn down into contact with the aponeurotic ridge. Suture material of medium thickness, a good needle, and considerable care will be required to enable the suturing to be executed without tearing the tissues. When the tissues are thin and friable, the posterior wall of the canal having altogether disappeared, or being represented only by a thin fibrous layer, instead of a continuous suture it will often be better to employ a series of interrupted sutures, including all the fibrous and muscular tissues which can be picked up above and below.

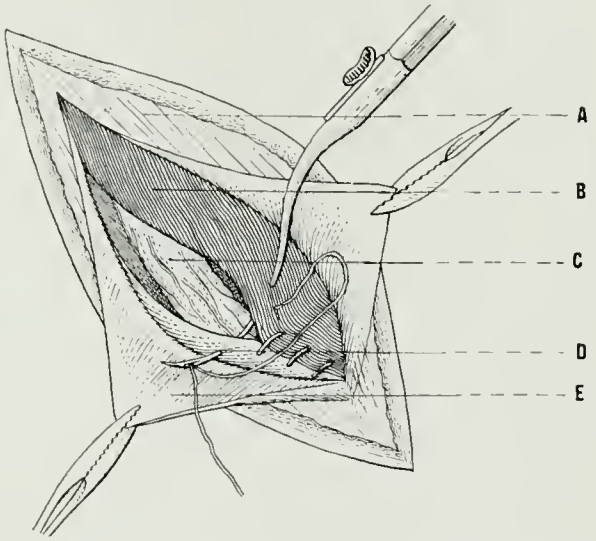


Fig. 130.—Inguinal herniotomy. 6th step: Radical cure. Restoration of the posterior wall of the canal; cord behind. (A) Aponeurosis of the external oblique. (B) Internal oblique and transversalis muscles. (C) Cord left behind the posterior wall of the canal. (D) Suturing the posterior wall. (E) Lower edge of the aponeurosis of the external oblique, turned downwards.

The suture will be continued outwards as far as the position of the internal ring, leaving just sufficient space for the passage of the cord; great care is necessary in introducing the outermost stitches; the fibrous ridge must be raised up as much as possible with the dissecting forceps, because the iliac vessels are not far away, and may very easily be injured; indeed, when the wall is thin, the vessels may be felt, and sometimes even the pulsations seen at the outer angle of the wound.

As soon as the deep suture is completed, the cord is replaced and the anterior wall of the canal—in other words the two edges of the external oblique aponeurosis—is sutured in front of it (*Fig.* 132).

A good continuous suture with closely-set stitches, commencing at the outer angle of the wound and continued inwards to the pillars of the external ring, will give very satisfactory results; but particular attention is necessary in introducing the stitches which approximate the pillars and restore the external ring.

It is very important, when suturing the posterior layer behind the cord, to include only the posterior border of the inguinal gutter, and to leave sufficient of the lower flap of the aponeurosis to provide a covering

for the cord. If the pillars of the ring have been properly exposed, they will be seen and felt as two very definite tense fibrous bands, extending inwards to the pubis. These bands must be sutured together, sufficient space being left between them for the passage of the cord; a few interrupted sutures at the upper border of the ring will often be very useful by providing additional support.

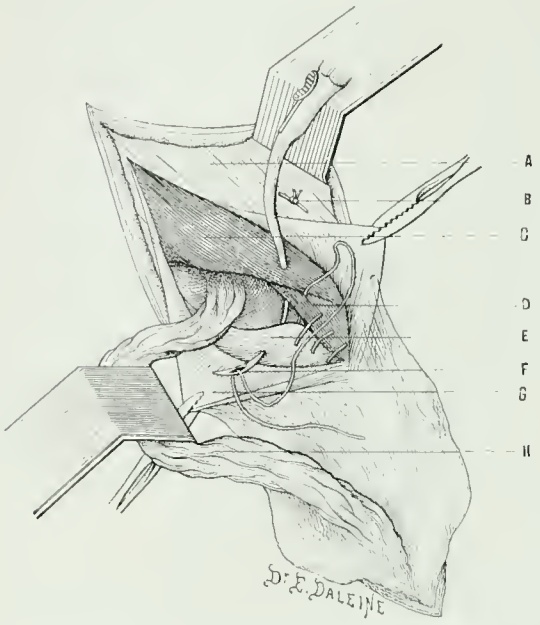


Fig. 131.—Inguinal herniotomy. 6th step: Radical cure. Restoration of the posterior wall of the canal; cord in front. (A) Aponeurosis of the external oblique. (B) The two ends of the ligature used in tying the neck of the sac, knotted in front of the aponeurosis. (C) Internal oblique. (D) Lower edge of the internal oblique and transversalis muscles. (E) Posterior border of the inguinal gutter. (F) Reverdin needle, passed through the lower border of the internal oblique and transversalis muscles and the posterior border of the inguinal gutter, and drawing through the continuous suture. (G) Lower lip of the incised aponeurosis. (H) Cord drawn aside.

Lucas-Championnière's method is better still:[1] the two edges of the aponeurosis are overlapped, the one being drawn under the other and fixed by three interrupted sutures, and the union completed by means of a continuous suture.

It is not to be forgotten, of course, that in a radical cure undertaken at the end of an operation for strangulated hernia which may in itself have caused considerable trouble and occupied a fairly long time, the same perfection and minute detail cannot be expected as in a radical cure undertaken as a primary measure under normal conditions.

Still, it must be recognized that in the majority of cases there is ample time for completing the operation properly, if the operator knows how to do it; at any rate, even if the restoration of the walls of the canal in two layers cannot be undertaken, it is at least necessary to unite the two edges of the external oblique aponeurosis, the lower border of the internal oblique and transversalis muscles, and all the fibrous tissues that can be picked up by means of a good continuous suture, and to approximate the two pillars of the external ring as accurately as possible.

Lower down the scrotal fibrous layer will be sutured over the cord, and lastly, the skin wound will be closed without drainage.

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[1] Lucas-Championnière, *Cure radical des hernies*, 1892, p. 193.

The dressing after these hernia operations is a very important point; the suture line must be carefully protected from the possibility of septic contact, to which the inguino-scrotal region is peculiarly exposed.

Several layers of aseptic gauze, fixed down at the margins and with the superficial layer covered with collodion, will provide a very good and simple protection, and one which is certainly much better than a large, loose mass of wool, fixed by a single spica, and which gapes at its inner border within a few hours.

It is a different matter, however, if the layer of wool is of reasonable thickness and is retained by a well-applied double spica which closes it in completely along the cruro-genital fold.

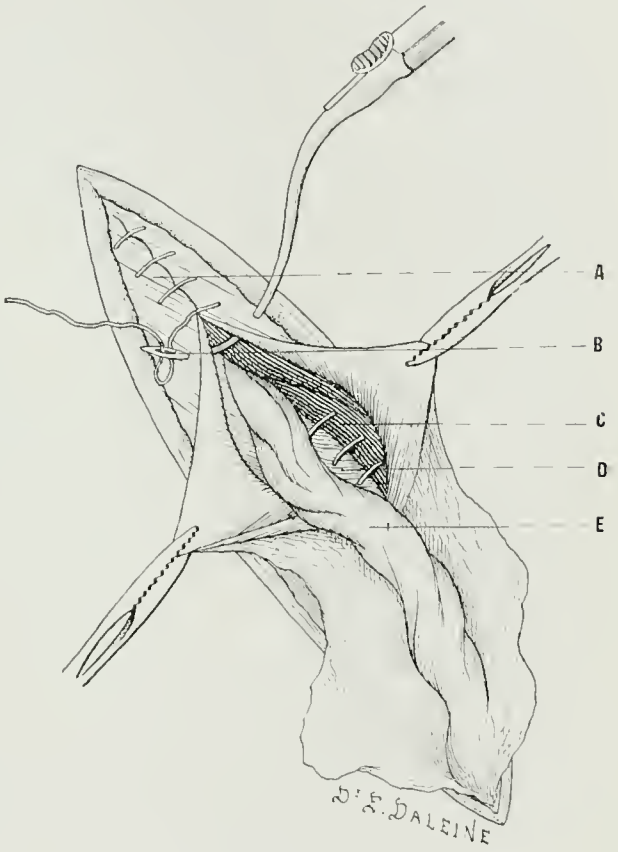

Fig. 132.—Inguinal herniotomy, 6th step: Restoration of the anterior wall of the canal. (A) The edges of the aponeurosis being united by a continuous suture. (B) Needle passing through the edges of the aponeurosis and continuing the suture. (C) Lower border of the internal oblique and transversalis muscles. (D) Line of suture in the posterior wall of the canal. (E) Cord replaced.

In my opinion all internal medication is contraindicated during the days immediately following the operation. I never give opium to a patient after an operation for strangulated hernia, and I consider that its administration is harmful. For the first twenty-four hours nothing should be given except a few teaspoonfuls of brandy and water or iced milk, if thirst is very trying. On the following day, if the bowels have not acted spontaneously, an oil enema should be administered and repeated if the first has no effect; on the second day after operation, unless the bowels are very loose, a gentle aperient is useful; castor oil in small doses, a teaspoonful hourly for five or six hours, following Verneuil's practice, is very good in these cases. Too much haste in stimulating the bowels to

action is to be avoided ; if the patient is passing flatus, there is no hurry. It is different, however, with old people, and with feeble patients who were already suffering from toxæmia at the time of the operation, when the abdomen remains distended and little or no flatus is passed ; one must not forget that in these circumstances intestinal paralysis may cause grave danger, and death, after a perfectly satisfactory operation and when all constriction has been relieved. The loop which has been strangulated does not recover its contractility, and at autopsy is found as distended as it was in the sac ; the paralyzed segment constitutes a complete barrier to the intestinal circulation, and further, the paralysis extends to the adjoining loops. The electric enema, if applied in time, is the best means of treating these secondary complications. (*See* INTESTINAL OBSTRUCTION.)

Below we shall consider other complications which may supervene after herniotomy.

COMPLICATED STRANGULATED INGUINAL HERNIA.

We do not include gangrenous herniæ under this heading ; they will be studied in a special chapter ; but we shall discuss the cases in which herniotomy is no longer a simple, definite, and comparatively easy operation ; the surgeon is checked at one or other stage of the operation by some special condition, some anomaly or complication. To avoid being puzzled, and to take the proper course without delay, he must be acquainted beforehand with the difficulties he may possibly encounter.

We shall therefore consider (1) *The adherent hernias ;* (2) *Anomalies of the sac* : double sac, diverticula, properitoneal hernia ; (3) *The hernias with abnormal contents* : bladder, appendix, ovary, tube, etc. ; (4) *The hernias transformed or complicated by preceding taxis* : reduction *en masse* and its varieties.

Lastly we shall describe the treatment to be adopted in dealing with *accidents which may occur during or after the operation.*

I. ADHERENT HERNIA.

The possibility of the existence of adhesions must be foreseen when strangulation occurs in a large, old-standing hernia, which has repeatedly been the seat of painful complications, and has for a variable time been only partially reducible.

The utmost care must be exercised in opening the sac, which will only be incised through a thin, well-raised-up fold ; if the intestine or omentum is extensively adherent to the anterior wall of the sac, in order to complete the incision, the way must be cautiously opened for the blunt blade of the scissors with the index finger and director.

A large mass of adherent omentum enveloping a loop of small intestine is found. Secure the two lips of the opened sac with a

sufficient number of forceps; put one of the edges on the stretch, and proceed to separate the adhesions with the finger from before backwards, keeping close to the inner surface of the sac; repeat the process on the other side, then work down to the bottom of the sac and liberate the lower extremity of the epiplocele and lift up the whole mass, so exposing the underlying discoloured loop of intestine.

If the adhesions are of comparatively recent origin, and easily broken down, the separation may be altogether effected with the finger, or the director, or the blunt closed ends of a pair of curved scissors; it will be most simply and satisfactorily performed *if care is taken not to lose touch with the inner wall of the sac.*

But the fusion is sometimes more intimate.

(*A*). Here and there, **thick, whitish, membranous patches may be found, binding the sac and the omentum together**; they must be separated by dissection with the scissors, parallel to the surface of the sac and, if necessary, encroaching on it.

(*B*). Elsewhere, and particularly below at **the fundus of the sac,** at the bottom of the scrotum if the hernia is a congenital one, there are **some dense, fibrous bands,** separation of which is almost impossible; do not attempt to rupture them by force, but apply forceps and cut below.

(*C*). Lastly, **large fringes of omentum are sometimes found to be incarcerated in narrow-necked pockets** or diverticula, and can only be liberated by incising the fibrous margin of the opening; if they are very adherent, the best plan is not to try to disengage them, but simply to apply forceps and then cut them; the attached portions will afterwards be removed along with the sac.

The separation of the omentum must be pursued *up to the neck of the sac*, and *beyond it if necessary*, after the constriction has been relieved; until the omentum can be pulled down freely, the work of separation is incomplete.

Not uncommonly fine bands are found, even in the vicinity of the neck, which allow the omentum to be drawn out to an apparently sufficient extent, but which will prevent complete reduction of the stump after ligature and excision; an effort must be made to separate these bands, and the operator must not rest satisfied until the finger, when introduced into the abdomen, cannot discover the slightest obstacle, and the omental pedicle when reduced slips away from the vicinity of the internal ring, into the general peritoneal cavity.

The liberation of **adherent intestine** is generally more difficult, and great care is necessary because of the constant friability of the bowel after being strangulated.

Soft and recent adhesions can be broken down with the finger; the separation must be effected gradually, the finger-nail being kept directed towards the wall of the sac: no strong traction must be exercised on the intestine.

In other cases the attachment is close and of long standing (*Fig.* 133), and the intestine is united to the sac wall by dense fibrous tissue, or the

two walls may even be absolutely fused together; in such circumstances the separation can only be effected by actual dissection with the knife or with curved scissors, the cutting edge being kept turned towards and, if necessary, encroaching on, the wall of the sac.

This dissection is a tedious and delicate piece of work, but it is of capital importance, and can only be satisfactorily carried out if patience and method are exercised; begin at the most dependent part, and work gradually upwards along the two limbs of the intestinal loop to the neck of the sac, until the entire mass is free and can be drawn down. Even then the task is not complete; the surface of the intestine usually presents membranous patches, fibrous areas, and bands, by which it is distorted and kinked; the bands and membranous patches must be carefully excised, one by one, with scissors and dissecting forceps; the loop must be "put in order," and straightened out before reduction; it must not be left acutely kinked with its two limbs adherent and parallel, like the double barrels of a gun (*Fig.* 133), ready to cause obstruction at any moment.

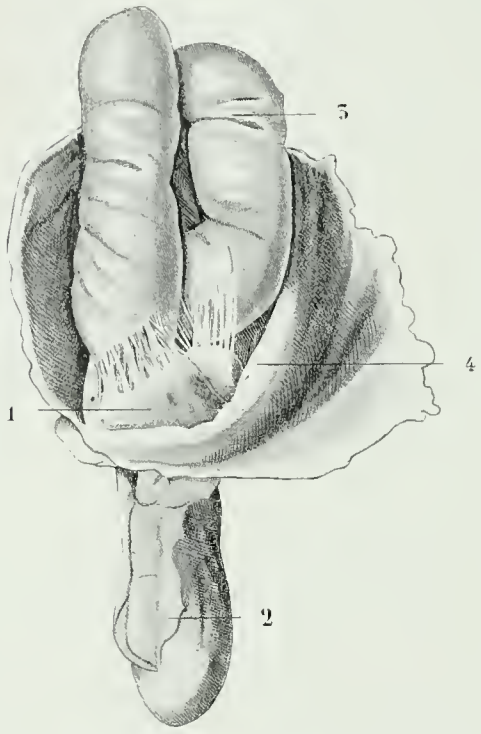

Fig. 133.—Old-standing inflammatory adhesions fixing the apex of the loop of intestine to the bottom of the sac and the two limbs together, like the double barrels of a gun. (1) Bottom of the sac pulled up by the adhesions. (2) Tunica vaginalis, independent of the hernial sac. (3) Adherent intestine. (4) The opened hernial sac. (Scarpa.)

The difficulties, it must be admitted, are sometimes very great, and various accidents may occur which exaggerate them still more.

First of all there is **hæmorrhage**, not so much the definite localized bleeding which results from the rupture or division of a vascular fibrous band, but *a very profuse and diffuse oozing*, coming sometimes from the whole of the separated surface, and which one is often at a loss to know how to check.

Compression for a few minutes with a pad of aseptic gauze generally lessens the bleeding considerably, and the chief bleeding points can then be more clearly seen; a few fine ligatures, if the bleeding vessels can be caught with pressure-forceps, one or two Lembert sutures, perhaps the very careful application of the small point of the thermo-cautery, will usually

suffice to staunch more or less completely the bleeding surface ; further compression will do the rest, and if a slight oozing still persists, this need not prevent reduction, because it will usually cease directly the intestine has been returned to its proper place and its liberty of movement and its normal circulation restored.

Then there are **the lesions of the wall of the intestine,** lacerations of variable extent ; they should always be carefully and immediately repaired before continuing the work of separation.

In some cases the friability is so great that the intestinal wall ruptures or splits on the slightest touch, and multiple lesions are produced ; in operating on a large strangulated hernia of old standing, I have seen six fissures produced, notwithstanding the extreme gentleness of my manipulations ; all the wounds were sutured, though not without trouble, and the contents of the hernial sac, after careful cleansing, were at last successfully reduced ; the patient recovered.

Extravasation of fæcal fluid is the great danger associated with these ruptures. The surrounding areas must be at once protected by aseptic compresses ; further, after troublesome separations, the interior of the sac and the surface of the intestine ought to be very carefully cleansed before reduction is performed, and the incision through the constriction ought always to be free enough to allow of the sac contents being replaced in the abdomen without any trouble.

Let us add that these accidents and difficulties are met with particularly in the course of *delayed operations.*

If liberation of the intestine cannot be effected, and time presses, one resource remains : **to relieve the constriction without reduction.**

It is a makeshift procedure, certainly ; but sometimes one may be able to save the patient's life by deferring the complete operation to a later date. In such a case, the neck of the sac must be freely incised, and the constricted portion of the loop of intestine—the pedicle of the hernia—disengaged with the finger, and released from pressure ; in the sac, the chief bands or adhesions which kink or compress the intestine will be divided or ruptured ; it is then necessary to make sure that the intestinal contents can be, partially at least, expressed into the abdomen, and that a free channel has been re-established.

Only if these conditions are fulfilled, and in case of extreme urgency, will it be permissible to adopt this incomplete procedure, the ultimate results of which are always uncertain ; as a matter of fact, in these old and large adherent hernias, the intestinal obstruction is due not so much to actual strangulation at the neck of the sac, as to angulation, kinking, and fixation of the bowel to the walls of the sac.

In such cases, even when the strangulating bands are divided, the intestinal loop, still fixed and adherent, only too often remains inert and paralyzed.

In this group of adherent hernias, we must also include **the hernias of the cæcum and sigmoid colon,** in which the mesocolon has slipped

down the posterior abdominal wall, and become attached to the posterior wall of the sac, sometimes in its entire extent. Further, the large gut often undergoes flexion in a forward direction, and its posterior wall separates from its peritoneal covering and comes into direct contact with the inguinal and scrotal cellular tissues; in other words, and without entering into any discussions regarding this point in hernial anatomy, the part of the large intestine which has slipped out of the abdomen is not entirely contained within the sac; a variable extent of *its posterior wall is extra-saccular* and denuded of peritoneum.

The following is a good example, and is the more instructive in that it refers to a case in which operation was performed almost immediately after the onset of the acute symptoms.

Case 14.—The condition was a large right inguinal hernia, incompletely reducible for several months, which had suddenly enlarged during a muscular effort and at the same time became irreducible and painful. I operated a few hours later without any preliminary taxis. The sac was opened without difficulty in the manner described above. I found the cæcum blackish in colour and enormously distended; its lower extremity was free, it could be raised, and the finger could be passed around it; behind and a little lower down, the curled-up appendix was visible; but higher up the posterior wall of the intestine formed part, so to speak, of the wall of the sac, over an area about two inches in length.

The constriction was relieved, and a small segment of the large intestine drawn out of the abdomen; the constricted portion was marked by a very definite groove, but was intact. Reduction pure and simple was quite indicated; but an insurmountable obstacle was created by the union between the sac and the bowel. The dimensions of the distended viscus were reduced by pressure with the fingers; but the retro-intestinal attachment became only the more definite; it absolutely refused to yield to any manipulations, remaining firmly fixed to and moving only with the sac.

The two edges of the sac were therefore separated and isolated from the surrounding tissues as if for the final excision; posteriorly they were continuous with a thick, tense, reddish-coloured wall, covered with large vessels and easily recognized as the posterior wall of the ascending colon. Bit by bit the posterior wall of the sac, and with it the adherent gut, was pushed back into the abdomen; finally complete reduction was effected. A neck was formed as well as possible with what remained in the wound of the sac wall, and after ligature and excision, the inguinal region was restored in the usual manner.

The hernias of the large intestine, associated with this special type of adhesion, produced by "*sliding*" *of the mesocolon* (*Fig.* 134), always give rise to great difficulty in treatment, and, as they are sometimes very puzzling, it is necessary to be well acquainted with the conditions which are most frequently encountered.

They are usually of large size, but it is exceptional to be able to foretell the nature of the contents of the sac, except in some cases of extreme distention, where the sacculations of the large intestine render themselves evident through the stretched and thinned overlying tissues.

The greatest care is always required in incising the sac, because the intestine is sometimes twisted or curved forwards on itself, in such a manner as to present its extrasaccular, posterior surface, bare of peritoneum in front, where it is very liable to be damaged with the knife. As a matter

of fact, one must be prepared to meet various abnormalities in position and relationships of the sac, and before doing anything else, the nature and arrangement of the sac must be determined ; direct attention therefore to the inner side of the sac, and if the reddish surface, which is first of all exposed, looks in the least degree unusual, do not hesitate to separate widely the whole anterior surface of the sac, and to look for a thinner and more easily plicated segment of the wall.

Once the sac has been opened, and the large intestine recognized, incise the neck freely—and the abdominal wall also if necessary—and after inspection of the constricted portion, reduce the volume of the herniated segment by emptying it by gentle pressure with the fingers, but without any attempt to push the bowel itself back into the abdomen.

The seat and extent of the natural attachment can then be exactly determined ; any attempt at reduction by force must of necessity be unsuccessful, and would also be very dangerous ; the wide bond of union between the cæcum or sigmoid colon and the posterior wall of the sac will not yield, and can only be mobilized and reduced with the sac itself. On the other hand, it must neither be ruptured nor divided, because either would expose the vascular supply of the intestine to the risk of serious injury. Begin therefore by isolating and liberating the sac above and behind ; separate it from the cord, and at the same time very carefully separate the retroperitoneal portion of the herniated large intestine, which presents itself without a peritoneal covering below the ring and the vascular tracts which run behind the intestine. Now proceed to reduce *en masse* the posterior portion of the sac wall, and the intestine which is continuous with it ; replace the retroperitoneal segment first of all, then the rest, bit by bit pushing the posterior wall of the sac upwards over the front of the cord, not the intestine over the posterior wall of the sac. **The attachment between the intestine and the sac must be respected ; it is the sac which must be liberated and reduced.**

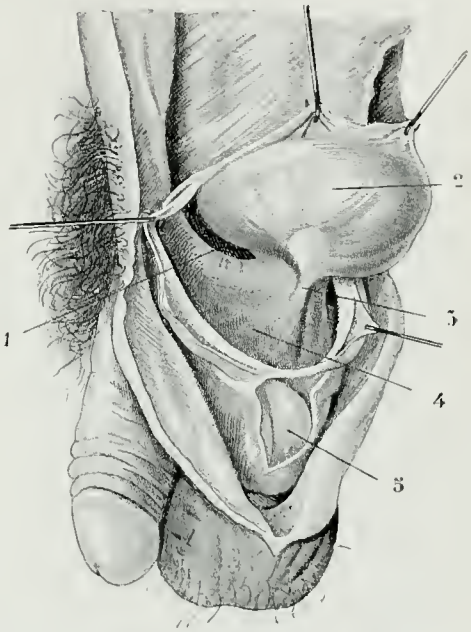

Fig. 134.—Dissection showing the attachment of the sigmoid colon to the wall of the sac, in a "sliding" hernia. (1) Neck of the sac. (2) Sigmoid colon drawn upwards, attached by its mesocolon to (3) The wall of the sac, (4) Which has been opened. (5) Testicle in the tunica vaginalis. (Scarpa).

Of course this reposition is possible only with the aid of a sufficient preliminary incision of the neck of the hernia and the inguinal wall, and it is advisable to provide all the room necessary at once; the inclined position is a great help in effecting reduction, particularly when coils of small gut have been protruded along with the large intestine and the volume of the contents of the hernia is considerable.

Finally, if liberation of the sac and reposition as a whole seem impracticable, there remains a last resource: *relief of constriction without reduction*, of which we have already spoken.

II.—ANOMALIES OF THE SAC.

ABNORMAL SITUATION OF THE CONSTRICTION.

The surgeon must be prepared for anything, and astonished at nothing, during the course of an operation for strangulated hernia. Theoretical considerations must be put on one side, and the whole energies directed to meeting the primary indications; and the task must not be considered complete until the intestine has been satisfactorily reduced and has disappeared into the abdominal cavity.

Certain anomalies of the exterior of the sac are sometimes encountered; but they are for the most part easily recognized, and give rise to little difficulty.

The usual incision having been made in the inguinal region and in the outer coverings of the sac, in the manner already described, an empty cavity is opened into, or perhaps a cavity containing merely a little serous or sero-sanguineous fluid: there is no intestine or omentum, and the pocket is closed in all directions; but on the deep wall of the first sac there is a prominence due to the presence of a second: the latter is the true sac, and the cavity which was opened first is a **presaccular serous pocket** or an old-standing **diverticulum**, the communication of which with the main sac has been completely obliterated.

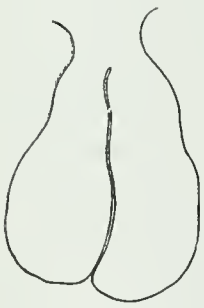

Fig. 135.
Bilocular hernial sac.

It is a simple matter after all, and need cause no trouble if ordinary care is exercised in incising the underlying partition which forms the true sac wall. In some cases a narrow channel will show the way from one pocket to the other, from the empty to the occupied cavity. It is needless to dwell further on the matter.

An encysted hernia of the tunica vaginalis (infantile hernia) presents very similar appearances; of which the following is an instance: A large, left scrotal hernia, evidently containing a large quantity of fluid: on opening the sac, much clear serous fluid escaped, and I entered a huge cavity, containing the testicle in its lower part and extending upwards to the external ring; there was neither intestine nor omentum

in the cavity; it was closed in all directions; this was the tunica vaginalis. At the middle of its posterior wall, however, there was a tense, rounded prominence, due to the presence of a second pocket, which was incised in its turn and proved to be the hernial sac.[1]

Sometimes the true sac, instead of lying behind the posterior wall of the tunica vaginalis, invaginates itself vertically from above downwards into the cavity, and is then situated in the very middle of the hydrocele. A knowledge of the possible existence of these abnormal conditions will suffice to prevent the operator being puzzled by them.

Double Sacs; Diverticula.—These conditions are more disturbing when encountered during the course of a herniotomy; the following case, one of my own, will serve as an illustration:—

A large right inguinal hernia, recently strangulated; operation. I opened, without difficulty, a sac which appeared at first sight to be absolutely normal; the neck was incised in the usual manner, and I reduced an intact loop of small intestine; but behind it, to my surprise, at the neck of the sac I found another loop engaged in a second sac, situated exactly behind the first, and separated from it by a serous partition; I liberated and reduced the second segment of intestine, then separated the **double sac** *en masse*, ligated it, and resected it.

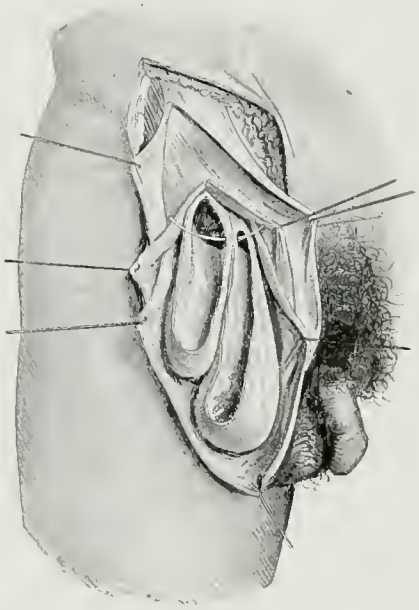

Fig. 130.—Inguinal hernia with a double sac. A thread has been placed in the opening between the two sacs. More deeply the opening into the peritoneal cavity is seen. (Demeaux.)

The sac was definitely **bilocular**, and the median diaphragm extended to a little below the neck (*Fig.* 135); sometimes the partition extends still higher (*Fig.* 136), and then there are two necks and two sites of strangulation: when the aponeurosis of the external oblique has been sufficiently incised at first, these peculiarities cause no serious difficulties.

In other cases, the sac may present, at some point of its inner surface, **a diverticulum**, a blind prolongation of variable size, **which contains the strangulated portion of the intestine**, and then the opening

[1] A perforation may occur through the thin partition separating the vaginal and hernial sacs, and may form a strangulating ring. In such a case, strangulated intestine will be found when the vaginal sac is opened. (Dupuytren, Bourguet, Berger.)

between the diverticulum and the main sac forms the strangulating ring. When these peculiarities exist, the physical characters of the hernia are often considerably modified: the swelling is soft and reducible in part, but there is another portion, harder and more tense, which cannot be reduced. "The tumour as a whole was soft," wrote Pierre Delbet, regarding a very typical case,[1] "slightly tense and resonant on percussion. On closer examination, however, a hard, tense, tender mass was felt behind the main swelling." The sac contained a large loop of intestine, perfectly normal in appearance, and the finger could be passed easily through the ring. Reduction was therefore begun; but it was soon perceived that a portion of the intestine was engaged in a diverticulum and was very tightly strangled by the margins of the opening between the diverticulum and the principal sac. It was necessary to enlarge the opening before the intestine could be withdrawn, and, owing to the tightness of the constriction, the incision was associated with considerable difficulty; the condition of the strangulated loop rendered resection necessary.

These **diverticula** may be situated at variable levels and on either wall of the sac; sometimes the communication is in the vicinity of the neck, and we find an arrangement which resembles that of a properitoneal hernia, except that it is outside the abdomen.

Properitoneal Hernia.—Here again there are two sacs of variable relative size, and communicating more or less freely; one of them is superficial, and **intra-inguinal,** the other deep, **intra-abdominal,** lodged between the parietal peritoneum and the fascia transversalis.

The deep sac is sometimes a direct prolongation of the intra-inguinal sac (*Fig.* 137); the two together forming an hour-glass shape, more or less bent at its intermediate portion; in other cases, and more frequently, the deep pouch deviates laterally and its mouth lies close to the mouth of the outer sac (*Fig.* 138).

Intermediate forms, of which many instances have been recorded, will be understood from an examination of *Figs.* 137 and 138. The important practical point to be remembered is that there is **a second sac** and **a deep-seated constriction.**

The intra-abdominal sac occupies different positions: most commonly it is situated behind the inguinal wall *in front of the iliac fossa*; sometimes it extends into the pelvis *behind the horizontal ramus of the pubis*, or again, it may extend in an inward direction *towards the bladder*. It is necessary to be aware of these different localizations, but in the great majority of cases it is impossible to recognize them in advance, and they are only discovered during operation.

These properitoneal hernias are, however, generally characterized by some peculiarity of evolution and some abnormal physical sign. The condition is not quite an ordinary, classical, strangulated inguinal hernia; there is something unusual and inexplicable about it; and the uncertainty

[1] PRIEUR, *Des sacs herniaires diverticulaires.* Thèse de doct., 1893.

is an additional reason for operating at once, without preliminary taxis. Here are some of the clinical varieties :—

(*A*). **There is no inguinal hernia**; the ring and the canal are free: **but above Poupart's ligament there is an elongated, ovoid, tense swelling**, more or less resonant, raising the abdominal wall; or perhaps, though there is no visible prominence, a deep-seated mass may be felt on palpation in the supra-inguinal region. The diagnosis will then often be one of intestinal obstruction.

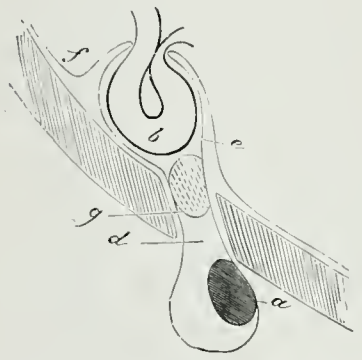

Fig. 137.—Properitoneal hernia, with the properitoneal sac placed above the scrotal sac. (*a*) Testicle contained in the scrotal sac (*d*) and slipping back to (*g*) where the hernia is retained by a bandage. (*b*) Intestine strangulated in the properitoneal portion (*e*) of the sac. (*f*) Parietal peritoneum. (Kronelin.)

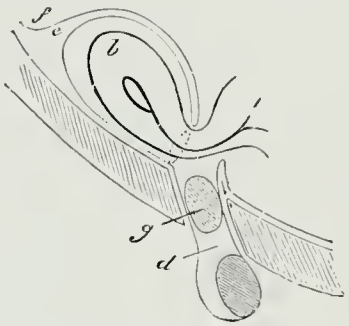

Fig. 138.—Properitoneal hernia, in which the properitoneal portion of the sac is situated laterally to the scrotal sac and to the common hernial orifice (the lettering is the same as in the preceding figure). (Kronlein.)

Case 15.—A man, some 50 years of age, was admitted to the Municipal Nursing Home with very grave symptoms of obstruction dating from four days previously. No sign of hernia was apparent; the abdomen was distended, and nothing was detected beyond the fact that pain was more acute and the tension greater in the right supra-inguinal region than elsewhere.

I opened the abdomen below the umbilicus, and at once directed my attention to the right iliac fossa. After some searching I found a loop of small intestine, which dipped into the pelvis and was fixed at its lower extremity; by following it from above downwards, I came upon a *hard, fibrous, circular ring* which encircled it and formed the entrance to a sac; this ring was situated to the inner side of, and at some distance from, the internal inguinal ring. I incised it, and extracted the incarcerated portion of the intestine, which was infiltrated, dark-coloured, and marked by a deep groove at the line of constriction. The sac was cylindrical, and about three inches deep; it extended downwards, forwards, and obliquely inwards across the anterior wall of the pelvis.

Owing to the necessity of finishing the operation speedily, the opening was simply obliterated from the inside with catgut sutures, and the abdomen closed. The patient recovered.[1]

[1] *Société de chirurgie*, 19 juillet, 1899.

(*B*). **There is an inguinal hernia,** but it is not very tense and **is partly reducible;** yet the symptoms of strangulation are definite and persistent.

In some cases of this kind, the deep swelling may be felt, and it may even be noticed that it becomes larger and more tense during the attempts to reduce the "external" hernia.

(*C*). **There is an "external" hernia,** not at all tense, however, and which can apparently be entirely reduced; but **as soon as the pressure is relaxed it returns,** and repeated attempts show that it is impossible to keep the intestine in the abdomen. True reduction has not been effected, the hernia has simply been displaced.

(*D*). Sometimes again there is an "external" hernia, which can be reduced without difficulty, **and remains reduced; but the symptoms of strangulation persist nevertheless.**

Further, we may add that in the majority of these cases some anomaly of the testicle is present: the organ is undescended, or perhaps it is discovered in the vicinity of the external ring or in the canal. **Malposition of the testicle, in relation to a hernia, ought always to arouse suspicion.**

Lastly, it may be that the "external" hernia presents all the signs of strangulation, and it is only during the course of the operation *after the first constriction has been relieved and the first reduction effected, that the existence of the deep pocket and the second focus of strangulation is discovered.*

We have already said that in every herniotomy it is essential to pass the finger into the abdomen and by a careful examination of the entire area in the neighbourhood of the internal ring to make sure that no abnormal condition exists. Through neglect of this important precaution, the contents of an intra-inguinal sac have sometimes been reduced into a properitoneal sac and an external strangulation transformed into an internal one, or the presence of a properitoneal sac has been overlooked.

In properitoneal hernias, in whatever guise they present themselves, the operation ought to be conducted in the following manner:—[1]

Perform ordinary herniotomy in the first place; open the external sac and incise the neck: if the sac is empty, or if the contents can be reduced without difficulty, follow the intestine with the finger and explore the retro-inguinal region to the outer side, the inner side, and below. Fairly often **a distended pocket** of variable size will be felt, and will at once convey the impression of a second sac; at other times **a distended loop of intestine** will be detected by the finger, and by following it, it will be found to be fixed at its extremity, or that it disappears under a sharp arching band.

If the reduction of the "external" hernia is impossible, or if, after

[1] When there is an external hernia, strangulated or not. If there is nothing in the canal, and a tense, rounded swelling is definitely felt above Poupart's ligament, a supra-inguinal incision should be made; very often, in such cases, it is possible to make a clear diagnosis of internal strangulation, and then a median sub-umbilical laparotomy will be necessary, as by it alone will it be possible to deal with all contingencies.

apparent reduction, the bowel slips out again immediately, the existence of a deep-seated obstacle will be evident, and that obstacle must be exposed to view.

Nothing is more dangerous or irrational than a blind attempt to incise a deep-seated and imperfectly-felt constriction within the abdomen, with the finger as the sole guide.

An effort must first be made, by pulling down the neck of the external sac and by retracting the inguinal incision, to expose the deep orifice, and if it is in the vicinity of the internal ring, the attempt will succeed.

Even the pressure of the finger has sometimes been sufficient to stretch the opening and to free the intestine; more frequently, however, it is necessary to incise the margin with a probe-pointed bistoury, or with curved scissors. But this measure, though it has the advantage of avoiding an extended incision in the abdominal wall, is not, as a general rule, to be recommended. Much the best plan is a **free hernio-laparotomy.**

The inguinal incision is prolonged outwards towards the iliac spine as far as may be necessary; the different layers of tissue are divided one by one down to the retro-parietal sac, which is widely exposed; its relations and situation are recognized and the neck is sought for, while the intestines are pushed back and kept out of the way under sterile compresses.

One or other of two plans may then be followed: if the neck of the sac lies close at hand and is easily accessible, it may be incised first and the incision prolonged on to the anterior wall of the deep sac; then, with every precaution, the incarcerated loop will be extracted, examined, and treated as the nature of its condition may demand. Sometimes it will be easier to begin by opening the sac, the thin wall of which will be cautiously raised and the incision prolonged through the neck.

In either case, it must not be forgotten that the sac is a true hernia sac, with septic contents, containing strangulated intestine which may be gangrenous and perforated; as the operation is being performed within the free peritoneal cavity, all necessary precautions must be taken to carefully isolate the area with gauze, and to guard against, or immediately remedy, any contamination.

Intra-abdominal sacs sometimes acquire a considerable size, and the neck may extend very high up. At all costs it is necessary to reach the neck, to accomplish which an extensive incision in the abdominal wall may be needed. In such circumstances the lesion is, strictly speaking, an actual internal obstruction, and the appropriate treatment becomes identical. Trendelenburg[1], in a case of this kind, performed median

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[1] The right half of the scrotum was occupied by a swelling as large as a hen's egg—not very tense and not tender—which extended rather indefinitely into the inguinal canal. The whole of the right portion of the hypogastric region was pushed forwards by a tumour the size of the two fists, elastic and painful, which, beginning below at Poupart's ligament, extended upwards to the immediate neighbourhood of the antero-superior iliac spine, and inwards to about three inches from the umbilicus. The scrotal sac was first opened: it contained omentum: the incision was prolonged over the anterior wall of the inguinal canal, and a mass of distended intestinal coils, with an omental band amongst them, was exposed. On following the omentum upwards and backwards with the finger, a ring, which appeared to be the cause

laparotomy; such a procedure will sometimes be unavoidable, but a hernio-laparotomy, as extensive as may be necessary, is the method of choice.

After the reduction of the contents of the deep sac has been achieved, the operation will be completed by careful suture of the various musculo-aponeurotic planes.

Inguino-interstitial Hernia.—Here the hernial swelling is entirely, or almost entirely, *in the abdominal wall*, and the seat of strangulation is high up at the internal inguinal ring.

In the typical form (*simple inguino-interstitial hernia*) the sac does not descend below the outlet of the inguinal canal; it does not, however, remain within the canal, but extends widely beyond its limits, burrowing between and separating the layers of the wall, upwards and inwards towards the umbilicus (*Fig.* 139). Usually the external ring is very small, and the testicle is undescended and situated in the canal.

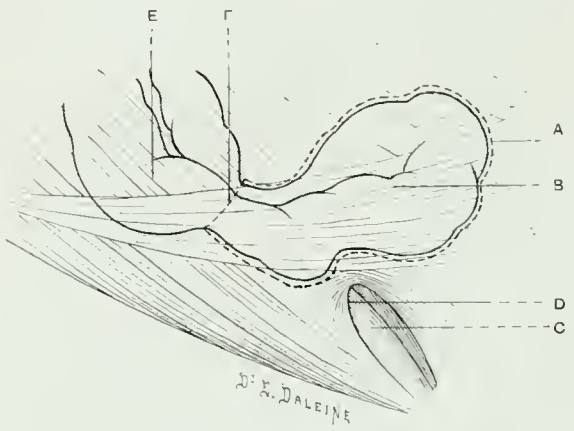

Fig. 139.—Inguino-interstitial hernia (diagrammatic). (A) The intraparietal sac. (B) Herniated intestine. (C) External ring, unoccupied. (D) The cord. (E) Upper end of the strangulated loop. (F) Neck of the sac, situated above and externally.

There is another, but rarer variety: the sac is again intra-parietal and develops chiefly in the supra-inguinal zone, but a prolongation extends downwards, passes through the external ring, and descends towards the scrotum. It is a *bilocular hernia*.

Although more common in men, the inguino-interstitial hernia has occasionally been observed in women; Auvray[1] has collected fourteen cases.

Symptoms of strangulation are by no means rare; the diagnosis is often difficult, and the operation itself requires a quite special technique.

It can be readily understood that in the simple, exclusively intra-parietal form, where there is no protrusion from the external orifice of the canal, and when a large, ill-defined tumour, enclosed by the musculo-aponeurotic planes, is found in the abdominal wall in the iliac region, there may

of the strangulation, was reached. An incision was made in the linea alba, sufficient to permit the introduction of the hand, which by gentle traction succeeded in disengaging and withdrawing the strangulated loop. A drain was left in the intra-abdominal sac. The patient recovered. (Reported by Hölder, "Ueber Hernia Pro-peritonealis" *Beitr. zur klin. Chir.*, 1891, Bd. vii., p. 271.)

[1] Auvray, "Hernie Inguino-interstitielle chez la femme (hernie de Goyrand)," *Gaz. hebd de méd. et de chir.*, 10 juin, 1900, No. 46, p. 542.

be considerable doubt as to the diagnosis; one thinks of an intra-abdominal tumour, an intussusception, an intestinal new-growth, an inflammatory mass. Undoubtedly, the variations in size and relief which the mass presents as a result of the abdominal contractions, may indicate its intra-parietal situation. When the patient tightens the abdomen the tumour becomes less evident. But in cases of strangulation, when the muscles of the abdominal wall are already in a state of painful contracture, too much reliance cannot be placed on that sign, particularly in a fat patient. However, in the presence of symptoms of obstruction, the discovery of a thick, flat, tender mass, more or less nodular, in one or other iliac wall, ought always to raise a suspicion of an inguino-interstitial hernia. The absence of the testicle from outside the external ring is a most valuable diagnostic point. Lastly, in the bilocular variety (*hernia en bissac*) the existence of the sub-inguinal prolongation indicates the nature of the large intra-parietal mass.

In such cases the operation is quite different from an ordinary herniotomy; a long, oblique, supra-inguinal incision must be made, following the long axis of the swelling; the aponeurosis of the external oblique—always distended and with its fibres often separated—is exposed and must be very carefully divided, because the sac lies immediately underneath and is very thin. Then, as a rule, the hernial sac is recognized, and any doubt which might have existed disappears. The sac in its turn is opened, cleansed, and explored. Note is taken of the route which the sac has followed in the abdominal wall, and of the plane which it has opened up; the intestine is disengaged, and the neck of the sac looked for, high up and to the outer side. The constriction is often comparatively loose, and as M. Tillaux has pointed out, the symptoms are to a great extent due to the acute angulation of the intestine. If it is necessary to divide the constricting ring, the incision will be made in an upward and outward direction, bearing in mind that the neck corresponds to the deep inguinal ring, and that the epigastric vessels lie to its inner side.

The isolation of the sac and its large intra-parietal prolongation is not always executed without difficulty, and it may be necessary to use the scissors in separating the adherent muscles; lastly, the large hernias leave a very considerable breach in the abdominal wall, which must be repaired, layer by layer, in the best manner possible.[1]

Retrograde Strangulation.—In these cases we have to do with an ordinary hernia, with an ordinary sac. The seat of strangulation is at the neck as usual, but the strangulated loop is not in the sac, *it is in the abdomen*.

Maydl[2] has described instances of this rare type of strangulation affecting the appendix and the tube (see later). A similar strangulation

[1] See BERGER's method: La hernie inguino-interstitielle et son traitement par la cure radicale. *Revue de chir.*, 10 janvier, 1902, No. 1, p. 1.

[2] MAYDL, "Ueber retrograde Incarceration der Tuba und des Processus Vermiformis in Leisten und Schenkelhernien." *Wiener klin. Rundschau*, 1895, Nos. 2 and 3.

of the omentum has also been observed: on opening the sac, an omental segment, more or less thick, and more or less adherent, is exposed; it is liberated all around, but the end cannot be found; and only after the neck of the sac has been freely incised has the terminal portion of the omentum been discovered higher up in the abdomen, sometimes adherent to the abdominal wall, and usually gangrenous. In a case reported by Bayer[1] (*Fig.* 140), there was also intra-abdominal torsion of the afferent omental segment. The intestine also may be strangulated "backwards;" here is an example.[2]

Strangulated right-sided scrotal hernia; herniotomy: the sac was filled with turbid, fœtid fluid of a reddish-yellow colour; it contained two

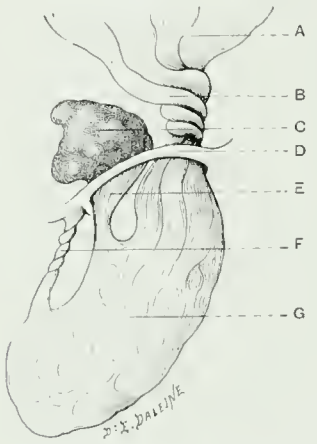

Fig. 140.—Retrograde strangulation of omentum. (Bayer's case, *loc. cit.*) (A) Omentum. (B) Intra abdominal torsion of the omentum above the neck. (C) Segment of omentum, gangrenous as a result of retrograde strangulation. (D) Neck of the sac. (E) Pedicle of the strangulated segment of omentum. (F) Small omental band, twisted and adherent to the neck. (G) Intrasaccular portion of omentum, not strangulated.

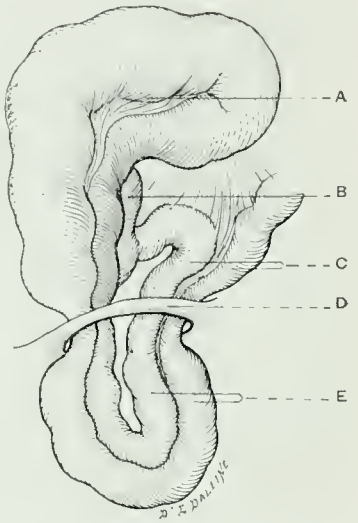

Fig. 141.—Retrograde strangulation of intestine. (v. Wistinghausen's case, *loc. cit.*, diagrammatic.) (A) Middle portion of the loop; retrograde strangulation. (B) Cæcum. (C) The two entering limbs of the loop. (D) Neck of sac. (E) Intrasaccular portion of the intestine, not strangulated.

loops of small intestine, distended and purple, but apparently little altered; the appearance of the intestine contrasted markedly with the fluid in the sac, which smelt of gangrene, and the two loops seemed independent, as if they had descended separately into the sac, side by side; in the neck there were four ends of intestine. The inguinal canal was laid open; an abundance of blood-stained, fœtid liquid escaped from the abdomen, and a loop about three inches long, extremely distended, covered with small hæmorrhages, blackish in colour, and gangrenous in places, was with-

[1] C. Bayer, "Retrograde Netz-incarceration mit Stieltorsion ueber den Bruchring." *Centralbl. f. Chir.*, 1898, No. 17. p. 462.

[2] R. v. Wistinghausen, "Zur Casuistik der Retrograden Incarcerationem." *Arch. f. klin. Chir.*, 1902, Bd. 68, 2. p. 419.

drawn ; it was the median portion of the herniated loop, and the nature of the condition then became clear ; the hernia consisted of a single loop of small intestine doubled on itself, the median portion having re-entered the abdomen and become strangulated at the ring (*Fig.* 141).

In these cases, therefore, two almost normal loops of small intestine are found in the sac, and it is *the intermediate, intra-abdominal segment* which is strangulated and sometimes gangrenous. In a case of M. L. Laroyenne's[1] the sac contained the cæcum and the end of the ileum on the one hand, and on the other a loop of small intestine, all in a quite healthy condition ; the sac fluid was lemon-yellow in colour ; on drawing down the intra-abdominal portion of the loop of small intestine, an intermediate segment about two yards in length, blackish, and in a condition of approaching gangrene (*Fig.* 142), was brought into view.

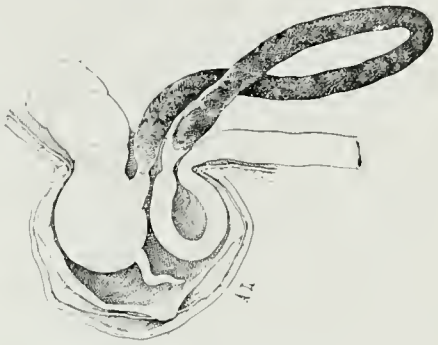

Fig. 142. Retrograde strangulation of intestine. (L. Laroyenne's case, *loc. cit.*)

Although uncommon, retrograde strangulation is a peculiarly grave condition ; the practical conclusion is this : the contents of a hernial sac, no matter how satisfactory their appearance may be, must never be replaced in the abdomen without a healthy portion of sufficient length having been first drawn down from above the ring, and without the whole zone of strangulation having been adequately explored, by the sac and into the abdomen ; when face to face with some abnormal arrangement, never reduce until the nature of the conditions is understood.

III.—HERNIÆ WITH ABNORMAL CONTENTS.

Under this heading we shall deal with (1) *Hernia of the bladder* ; (2) *Of the appendix* ; (3) *Of the ovary and of the tube.* They may occur independently, or associated with an intestino-omental hernia. In the same group we shall also include (4) *Certain hernial new growths.*

1. **Hernia of the Bladder.**—To a certain degree, when dealing with a reducible hernia under conditions which permit of a leisurely examination, the existence of an inguinal cystocele may be recognized, or at least suspected. The difficulties and peculiarities associated with micturition ; the discovery,

[1] L. Laroyenne of Lyons, " Hernie compliquée d'étranglement rétrograde de l'intestin," *Gazette des Hôpitaux*, 20 février, 1907.

at the inner part of the hernia, of a rounded, fluctuating swelling, which fills and empties with the bladder; or the presence of a thick, soft, flat mass, completely or imperfectly reducible, and which can be distended by injecting fluid into the bladder by the urethra: these various signs, when carefully considered, will enable a definite diagnosis to be made, or will at least arouse suspicion.

It is very different, however, when the hernia is strangulated and when no history can be obtained; the cystocele is then only discovered during the course of the operation, and often it is wounded.

First let us mention strangulation of a *pure cystocele*,[1] inguinal or femoral. The hernial swelling is, in this case, formed by the bladder alone; there is no sac, or only a small one, situated above and to the outer side. The condition is therefore not a true incarceration, and the lesions of the "strangulated" bladder segment are not usually pronounced, and rarely go on to gangrene. But the symptoms may appear very suddenly, and may closely resemble those of hernial strangulation: tension and irreducibility, pain radiating over the whole abdomen, vomiting; vesical symptoms (frequent and painful tenesmus, retention of urine, etc.) seem to be comparatively uncommon, or, at any rate, seldom attract attention.

During the course of a hernia operation, a lobulated fatty mass is found, and under it a reddish, fleshy wall, which may be taken for a thick sac. Here is the danger: if, deceived by first appearances, one endeavours to open the supposed sac, it is the bladder which will be incised. Exercise caution; examine the tumour all round, free it, divide the fibrous bands which envelop it, endeavour to follow it into the depths; and if examination by the eye, and particularly with the finger, shows that it extends downwards and inwards, its true character will be settled. Sometimes a small, empty saccular cavity may be opened, which will then be recognized as the interior of a cystocele.

It is necessary to provide sufficient room, to excise the pre-hernial lipoma, to freely incise the inguinal wall or Gimbernat's ligament, and to attempt reduction. If the protruding vesical segment has a bad appearance and threatens to become gangrenous, or if it forms an actual diverticulum, or again, if it has been seriously eroded or lacerated during the earlier investigations, it should be resected and the vesical wound sutured in the way we shall presently describe.

In cases of strangulated entero-cystoceles, the bladder presents itself during the dissection of the sac in two ways, either **within** or **without the sac.**

The former condition is the more uncommon. The herniotomy is done, the neck of the sac incised, and the contents are reduced; to the inner side and below, a second swelling is then noticed, rounded, tense, greyish or reddish in colour, as large as a nut or an egg, sometimes as large as the

[1] See A. Gruger, *Des accidents et des complications des cystocèles herniaires (inguinale et crurale), en particulier des accidents d'étranglement dans les cystocèles pures*. Thèse de Paris, 1908.

fist, and *which gives the impression of a second sac.* This has been the first impression of the majority of the operators who have met with this intra-saccular hernia ; some have been led to incise the supposed sac and, after dividing the serous covering, have come down upon a felted net-work of muscular fibres, the muscular coat of the bladder.

In such circumstances, direct incision of the supposed sac ought only to be the last step ; begin by examining it very carefully ; **follow it upwards, into the inguinal canal and into the pelvis,** enlarging the incision in the neck of the sac if necessary : commonly this will conduct the surgeon inwards behind the pubis to the bladder, and the exact nature of the swelling will be made clear.

That is what happened in a very typical case recorded by Walther.[1] The sac contained : (1) a large cystic swelling, emerging from the inner part of the inguinal ring ; (2) a strangulated loop of intestine occupying the outer part of the ring. The swelling descended right to the bottom of the sac, absolutely free from adhesions and covered with peritoneum. On introducing the finger into the inguinal canal, it was easily determined that the upper part of the swelling, gathered into a sort of pedicle, dipped into the pelvis behind the pubis : it was, in fact, *a hernia of the fundus of the bladder.*

In such circumstances, the vesical hernia can be reduced like a loop of intestine, and this is the first step to be undertaken ; if the prolapsed intra-peritoneal portion has dragged after it a segment of the extra-peritoneal part of the bladder, the reduction will be completed by following the procedure which will be described immediately.

More often, however, it is the other variety of cystocele which is encountered ; the herniated bladder does not show itself, when the sac is opened, in the form of a supplementary, well-defined sac ; the earlier steps of the operation are carried out without any peculiarity being observed, and it is only towards the end—when the attempt is made to separate the sac—that there is discovered, **behind and to the inner side of the sac,** never in any other position, a thickening covered and masked by fat, sometimes a sort of flat, doughy tumour, which extends deeply at the inner side of the ring and is drawn out more and more along with the neck of the sac.

The danger lies in taking this thickening for a part of the wall of the sac, and in seeking to separate it from the surrounding structures, or again in applying a ligature around the supposed thickened neck of the sac and dividing the sac below. In the latter case, after some days, the formation of a urinary abscess, and subsequently a urinary fistula, will indicate the real nature of the so-called thickening, and one will have cause to regret having transgressed the general rule of not ligating the neck of the sac until it has been completely freed in its entire circumference and reduced to the serous layer only.

[1] Walther, *Bull. de la soc. anat.*, 5 avril, 1895.

On the other hand, if, conscious of the necessity of properly isolating the neck of the sac, one pursues the task blindly and with some degree of force, very often a sort of polycystic mass, a series of translucent, thin-walled vesicles, will make its appearance under the fat and the apparently fibrous layers which the finger has just eroded and separated. The nature of these pseudo-cysts may at first sight give rise to a good deal of doubt; they are blind prolongations of the distended vesical mucosa, showing themselves through the gaps in the muscular coat of the bladder: they soon rupture, the urine escapes, and the appearance of the large, mucus-lined cavity into which the finger enters removes the last elements of uncertainty. If the parasaccular cystocele is not recognized until too late, and the separation is actively pursued, a very considerable breach may be made in the wall of the prolapsed bladder.[1]

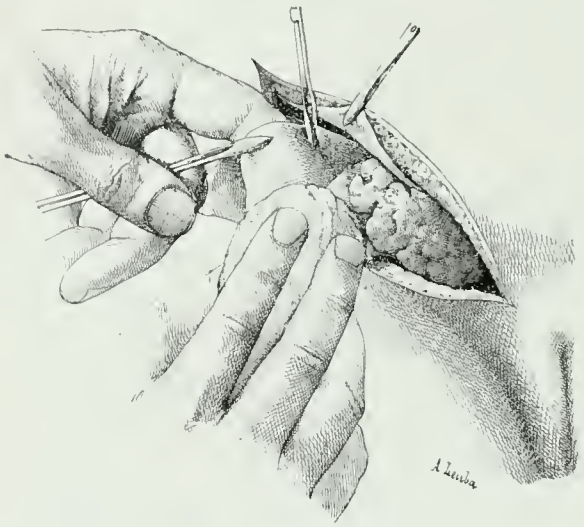

Fig. 143.—Hernia of the bladder.—The neck of the sac is stretched over the index finger, while the mass of fat and the bladder wall are being gently pushed back with a swab.

Any thickening, any doubtful tumour in the wall of the sac, ought therefore to arouse suspicion and direct the thoughts to the bladder; the presence of a large lipomatous mass is an additional and valuable sign, because, as a matter of fact, a **prevesical lipoma** is very seldom lacking in these cases.

Without endeavouring to liberate the sac further, begin by gently separating and retracting the fat; under this a fibrous-looking, greyish or reddish surface will be found, and on following up the apparent tumour convincing evidence of its nature will soon be obtained.

Exercise the greatest care in attempting to separate it from the sac wall, keeping close to the serous layer and effecting the separation with a swab or a piece of gauze (*Fig.* 143), and stopping as soon as the adhesion between the two becomes intimate: then push back what remains, enlarging the inguinal opening if necessary. During the dissection there will always be a considerable amount of oozing, but this can be readily stopped by a little pressure: further, there need be no surprise if blood is found in the urine for two or three days after the operation.

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[1] See Monod et Delagenière, "Contribution à l'étude de la cystocèle inguinale." *Revue de chirurgie*, 1889, p. 701.

If the cystocele has only been recognized after it has actually been torn, do not be unduly disturbed by the accident ; it is unfortunate certainly, but it has happened to others,[1] and if proper measures are adopted, the consequences will not be very serious.

To close the neck of the sac, and protect the peritoneum and the wound with gauze compresses, is the first precaution to be taken ; then secure the edges of the tear in the bladder with Kocher forceps, free them sufficiently to allow of the necessary suturing being executed easily and without tension, trim them with scissors, and devote all possible attention to making a good suture.

It is well to begin with a continuous suture of fine catgut for the mucous membrane, for the purpose of approximating the wound edges, in preparation for the more important suture of the muscular coat, which naturally includes only the outer layers of the bladder wall, and is introduced in such a manner as to bring, not merely the edges, but good broad areas of the outer surface into close contact ; either a continuous suture with closely placed stitches, or a series of interrupted sutures may be employed. If there are any doubts as to the security of the closure, do not hesitate to apply a complementary continuous suture including the superficial muscle layer and the neighbouring connective tissues over the first line of suture.

It then only remains, as before, to isolate the "repaired" cystocele as well as possible and to reduce it. The further steps of the herniotomy will be carried out in the ordinary manner ; if the laceration has been extensive, and much urine has escaped into the wound, it will be well to leave a drainage tube at the inner angle.

If this line of treatment is followed, the accident will as a rule be attended by no bad results ; at the worst there may be a urinary fistula, which will usually close without much difficulty.

In cases of very extensive vesical wounds, and if complete suture presents considerable difficulties, there remains the resource of placing and fixing a tube in the bladder, and suturing the bladder-wall around it, thus guarding against urinary infiltration ; but, if possible, the perforation should always be closed.

2. **Hernia of the Appendix.—Appendicitis in a Hernial Sac.**— The appendix, prolapsed along with the cæcum, may be found in the sac of a strangulated hernia ; it may be intact, or may present no lesions other than the congestion and œdema which result from the circulatory disturbances common to all hernial contents ; in any case, however, except when it is absolutely necessary to finish the operation as speedily

[1] In 1893 we collected 20 cases of operative lesions of the bladder during the course of hernia operations (*Revue de chirurgie*, t. xiii., p. 13 and 111). Professor Berger in 1898 (*Traité de chirurgie*, t. vi., p. 388) noted that of 59 recorded cases of inguinal cystocele, in 14 only had the condition been recognized at operation, before the bladder had been damaged. In 40 cases the bladder had been injured during the course of an operation for strangulated hernia or for radical cure, and in 15 cases the accident was only recognized after a period varying from several hours to several days. See also Fargin-Fayolle, *Contribution à l'étude des hernies de la vessie*. Thèse de Paris, 1903.

as possible, the appendix should be resected. These cases, therefore, present no special difficulty; it is a very different matter, however, when **appendicitis occurs in a hernial sac.**

Whether strangulated or gangrenous, the appendix is then the primary cause of the symptoms, which differ somewhat from those of an ordinary strangulated hernia. These special characteristics may raise suspicions of an appendicular hernia, but are rarely sufficient to warrant a definite diagnosis. Sometimes there is a large, right-sided inguinal hernia of old standing, which has suddenly become painful, irreducible, and tense, and complicated by abdominal distention, vomiting, and a more or less intense peritoneal reaction; but intestinal obstruction is often incomplete, flatus at least being still passed; the symptoms, in fact, are those of **hernial peritonitis**, the "inflamed hernia" of the old writers, rather than those of definite strangulation. The external appearances also are indicative of an inflammatory condition: the skin is red and œdematous; sometimes indeed there are actual accumulations of pus beneath it.

The need for immediate open operation is then quite as urgent as in a case of true strangulation, perhaps even more so; the contents of the sac will show us, in a moment, what disastrous results might accrue from ill-advised taxis.

In other cases, the hernial swelling has appeared quite recently, or has only acquired an appreciable size a comparatively short time before; it is definitely inflammatory and suggests a fæcal abscess due to gangrene of a lateral strangulation; as before, the symptoms of obstruction are incomplete, and the clinical picture is rather that of peritonitis than of strangulation. Here again, operate at once; this will reveal:

(*A*). **A Hernia of small or moderate size.**—The operation is performed in the ordinary manner; on cutting into the sac it will often be found greatly thickened, composed of a number of superposed layers, reddish-grey or yellowish in colour, and infiltrated with pus; sometimes, indeed, it may be necessary to traverse an actual abscess cavity in opening the sac. These points in themselves will always raise suspicions as to the nature of the underlying condition.

In the sac, one of three possibilities may present itself:—

(*a*). *The sac contains nothing beyond a variable quantity of turbid, greyish-red, fœtid or definitely purulent fluid*; no intestine, no omentum.

Explore the neck of the sac, from whence the fluid continues to flow: the finger alone will sometimes recognize a small rounded mass, or a firm cylindrical cord deeply situated at or behind the internal inguinal ring; but to determine the exact condition of affairs and to enable the proper treatment to be carried out, the neck must be opened, and the incision will then come down on a low-seated focus of appendicitis at the entrance to the hernial sac which has just been opened. Liberation and excision of the appendix, cleansing of the inflammatory focus, drainage *by way of the sac*, and partial closure of the wound complete the operation.

(*b*). *The sac contains the appendix alone.*—The lesions may vary from simple reddening and swelling of the organ, to gangrene, perforation, or

rupture—partial or complete. These are in fact the usual lesions of acute appendicitis, and there can be no doubt that in the majority of strangulated hernias of the appendix, the inflammatory process is not associated with strangulation, properly so-called.

Whatever may be the pathogeny, however, the proper treatment remains the same : after the sac has been carefully cleansed, the neck must be incised sufficiently to provide free access to the deep focus, and to allow the appendix to be drawn down and liberated up to its cæcal attachment. Sometimes the organ may present itself by its middle part, its reddened, distended, almost unrecognizable "body," which, sharply bent on itself, has alone slipped into the sac, while the tip has remained in the abdominal cavity, above the internal ring, where it has sometimes perforated (*Fig.* 144). This **retrograde incarceration**[1] must not be forgotten. Plenty of room must be provided, and the ascending extremity, followed with the finger, gently liberated and extracted. The removal of the organ will then be practised in the usual manner. (See APPENDICITIS.)

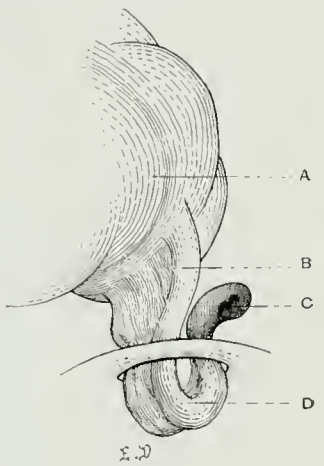

Fig. 144.—Retrograde strangulation of the appendix. (A) Cæcum. (B) First portion of the appendix. (C) Extremity of appendix, gangrenous and perforated as a result of retrograde strangulation. (D) Intrasaccular loop of the appendix.

If the symptoms are of recent date and there is no appendicular perforation, and no fœtid, suspicious fluid in the sac, a radical cure may be performed and the wound completely closed : in the majority of cases, however, drainage will be required.

(*c*). *With the appendix, a segment of omentum is found in the sac.* The amount of the omentum varies ; it is usually very adherent, and it is the first structure to come into view when the sac is opened. It is only after the omentum has been separated and raised that the appendix is perceived lying at the back of the sac.

The appropriate treatment is quite evident, and consists in the ligation and excision of the omentum, in the extraction and removal of the appendix, the wound being sufficiently enlarged to meet the exigencies of the case.

All the conditions just described present themselves, as a rule, unexpectedly : still, it is to be noted that the hernial swelling not seldom

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[1] Mouchet, of Sens, has published a very instructive case : it related to a woman, 70 years of age, with a right inguinal hernia : after the sac had been opened, not without some difficulty, a small hard mass, with a smooth surface and of a deep red colour, was isolated. The ring, which was not very tight, was incised, and an attempt was made to draw down the herniated mass in order to determine the state of its walls ; the attempt, however, proved unsuccessful. On introducing the finger into the inguinal canal to discover the cause of the failure, a hard, irregular cord, not at all like intestine, was felt ; going more deeply a free extremity was detected, and it was then recognized that the herniated mass was the appendix doubled on itself. After gently separating the adhesions, the organ was drawn out and resected. Excision of the sac, subcutaneous drainage. Recovery. ("Appendicite herniaire simulant un étranglement de l'intestin ; kélotomie ; résection de l'appendice ; guérison." *Gazette hebd.*, 9 décembre, 1900, No. 98, p. 1165.)

exhibits certain appearances which are a little unusual or suspicious, and which ought to put the operator on his guard; further, the contents of the sac after a little investigation will perhaps speedily reveal the exact nature of the condition. The operation will then differ in no way from the ordinary operation for appendicitis, except that it is performed in the opened hernial sac.

(*B*). **A large Cæco-appendicular Hernia.**—Here the local condition is usually more complicated and the operation more difficult.

Let us consider first of all the most common case, that of **a large, old-standing hernia,** "inflamed" rather than strangulated, and with a definitely inflammatory external appearance. Herniotomy is performed, and in the sac thick, fœtid, reddish fluid, suggestive of intestinal gangrene or perforation, is found; the herniated coils are glued together and covered with purulent lymph: on separating them the cæcum is discovered occupying the posterior wall of the sac, and also a focus of appendicitis. Further, the neck is not very tight, there is no strangulation, properly so-called, and at no other point does the intestine appear to be affected. It is a case of appendicitis in the midst of a hernia, and the technique would be identical with that applicable to appendicitis in the iliac fossa, were it not necessary to reduce the coils of small intestine and the cæcum, which form the walls of the intrasaccular inflammatory focus.

Begin therefore by enucleating and resecting the appendix, and by treating the peri-appendicular focus; a thorough washing of the whole of the sac contents by means of warm boiled water, and dry cleansing of the entire surface of the intestine with aseptic gauze swabs, constitutes the next step; if any omentum is present, it will be ligated as high up as possible and resected, then the coils of small intestine will be reduced, and finally, attention be directed to the cæcum, the walls of which are often infiltrated and friable where they have been in contact with the inflammatory focus; and naturally great care is required in handling them.

It may be that the original appendicular lesion has been less quickly and easily recognized; the sac is filled with adherent intestine and omentum, which are separated with difficulty, and it is only towards the end of the operation that **the appendix, more or less diseased, is found, quite posteriorly, embedded in the wall of the sac.**

This brings us to another group of cases in which the hernial appendicitis gives origin to **an extra-saccular abscess.** In a patient of M. Gangolphe's[1] there was a large, right-sided inguino-scrotal hernia, which had become painful and irreducible some days before: the swelling was as large as an infant's head, "the scrotum at its infero-internal part was hot, red, and very sensitive to pressure." A little later, a scrotal abscess was opened, containing about a glassful of very fœtid pus; but neither gas, foreign body, nor fæcal concretion. The wound healed rapidly, and at the

[1] Gangolphe, "Hernies du gros intestine. Appendicite herniaire." *Lyon médical*, 1892.

operation for radical cure which was ultimately performed, the appendix was found embedded in the wall of the sac, quite at its lower part.

This case indicates the safest line of action when there are no pronounced hernial symptoms; but it is not always so, and the appendicitis fairly often manifests itself by intra- and extra-saccular phenomena. An abscess is discovered in the coverings of the sac, and at the same time there are grave signs of hernial "inflammation," or of pseudo-strangulation of the peritonitic type, which make a complete operation necessary.

We find an excellent illustration of this in a case recorded by M. Aug. Pollosson[1]: here again, there was an enormous inguinal hernia, with a reddened and infiltrated scrotum; but the symptoms, at first mild, had become much worse, with fæcal vomiting. During the isolation of the sac, an abscess about the size of an egg, lying in contact with the postero-internal part of its outer surface, was opened. The cavity was carefully cleansed; the sac was then incised along its anterior surface, and it was found that the hernia contained a large loop of small intestine, the cæcum, and a part of the ascending colon; at the same time, a quantity of yellowish and somewhat turbid but not purulent fluid escaped. The cæcum was situated on the posterior surface of the sac; the cæcal end of the appendix was visible, but its free extremity could not at first be seen; however, on following the appendix along from the cæcum, it led into the extra-saccular abscess cavity, and it was evident that at that point the appendix was almost completely destroyed.

Under such circumstances, before opening the sac the abscess should first be incised and emptied; the sac should be opened as far away from the abscess as possible, usually on its anterior surface. The reduction of the sac contents may be extremely difficult: instead of trying to reduce the cæcum and the attached part of the sac—contaminated with pus and always impossible to disinfect completely—it will often be better to leave the lower cæcal segment outside the abdomen, after having provided for the restoration of the fæcal current by free incision of constricting bands.

3. **Hernia of the Ovary and Tube.**—We must refer but very briefly to these conditions. It almost always comes as a surprise when **an ovary and a tube are found to be the sole contents of the hernia,** or when they are met with **in a sac containing also intestine and omentum.**

In the first hypothesis, ovariocele pure and simple,[2] symptoms may arise resembling those of strangulation or, perhaps more closely, those of hernial "inflammation." Although certain features are lacking in the clinical picture, the indications for operation are none the less urgent, in the presence of a painful, tense and irreducible hernia, especially when redness and œdema of the coverings indicate an acute process.

After the sac is opened, the line of treatment will depend on the state of the ovary and the tube.

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[1] Quoted in the thesis of J. Charnois, *Des hernies du cæcum compliquées d'appendicite*. Lyon 1894. No. 984, Obs. ix.

[2] It is not very uncommon in little girls during the first two years of life.

If the contained fluid is clear, serous, and odourless, if the two organs present merely superficial congestive lesions, if the stretched and plicated broad ligament which forms the pedicle is likewise intact, then they may quite well be reduced, after the necessary relief of any constriction which may be present, and the operation terminated by a careful radical cure.

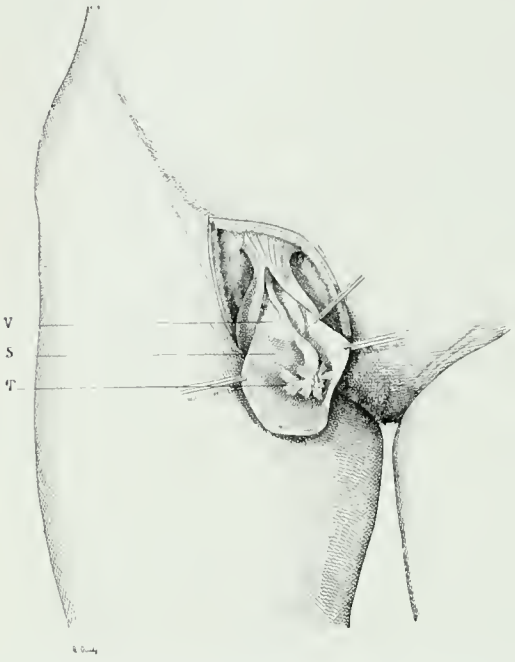

Fig. 145.—Inguinal hernia containing the tube. The hernial sac (S) has been laid freely open. The tube with its fimbriated extremity (T) is seen. At (V) a prominence in the lower wall of the sac indicates the situation of the herniated bladder.[1]

It must be recognized, however, that in cases of strangulation or pseudo-strangulation, these conservative measures are too seldom applicable: the sac fluid is sanious and fœtid; the tube, swollen, distended, and with a coating of yellow lymph which extends on to the ovary, is sometimes gangrenous; the pedicle, sometimes twisted, is eroded, friable, and discoloured: the sacrifice of both organs is then unavoidable. The pedicle must be drawn down sufficiently to allow of the ligature being applied to a healthy part of the broad ligament, and then divided.

Lastly, the tube alone may be found in a hernial sac; we have studied these **isolated hernias of the fallopian tube** (*Fig.* 145), and

[1] This was a case of simultaneous hernia of tube and bladder. The patient, a woman, 30 years of age, presented somewhat unusual symptoms of strangulation: the temperature was 102°, the abdomen distended, the tongue dry; the hernial swelling in the right groin was as large as an egg, completely irreducible, very tender, and its surface was a little reddened. The sac contained a considerable quantity of reddish, strong-smelling fluid, and the cavity seemed almost empty. On its lower wall there was a sort of cord, of a dusky-red colour and blackish in places, which ended in front in a thickening, and behind extended up into the ring. We speedily recognized this cord as the fallopian tube: its calibre, its sinuosities, and above all its fimbriated extremity, indicated its nature; the orifice was somewhat dilated, and from it drops of pus escaped on the slightest pressure. The ring was very tight: the tube was actually strangulated and could not be drawn down. After incising the ring, I pulled down a length of healthy tube. The contrast between the discoloured, flaccid, herniated portion of the tube, and the smooth, red, healthy, abdominal portion, was very definite: there was a well-marked groove at the junction of the two parts. The tube was ligated and excised with the thermo-cautery. In separating the sac, I found an intimate connection between its posterior wall and a firm, greyish, fibrous layer of tissue which occupied the supero-internal part of the inguinal space: suddenly I noticed a series of small, translucent vesicles appear under my finger, one of which burst and gave issue to a jet of urine. The bladder was repaired and healing ensued. (" Hernie inguinale simultanée de la trompe utérine et de la vessie. Les hernies de la trompe. Les lésions opératoires de la vessie herniée." *Revue de chirurgie*, 1892, pp. 12 and 111.)

M. Garrigues[1] has collected 43 instances, of which 25 were inguinal, 14 femoral, and 1 obturator.[2] The acute symptoms to which they may give rise may be due either to strangulation or to hernial salpingitis; the diagnosis can scarcely be made except during the course of the operation.[3]

4. **Tuberculosis and New Growths in a Hernia Sac.**—These are quite exceptional occurrences it is true, when the frequency of strangulated hernia is taken into consideration;[4] still it is well to be aware of their possible existence, and to be acquainted with those complications which may modify the clinical course of the hernia and the operative technique.

(*A*). **Tuberculosis**, when it manifests itself in the form of **miliary tubercles**, limited to the wall of the sac or affecting both the sac and its contents, creates no special difficulty in the operation: the ultimate prognosis alone is seriously aggravated.

The sac having been opened, one is surprised to see its inner surface covered with numerous rounded greyish and yellow granulations, sometimes discrete and restricted to a limited area, at the bottom of the sac, for instance, but more often spread over the whole extent. The surface of the intestine and omentum is sometimes quite normal, and the case is one of *saccular tuberculosis*, possibly limited to the sac, but as a rule implicating also the parietal peritoneum. This is what I found in the case of a woman some forty years of age, who, however, also presented fairly advanced pulmonary lesions: the hernia (it was a femoral hernia) was reduced and the sac resected; an uneventful recovery followed.

In other cases general hernial tuberculosis is found, again of the granular type, but affecting both sac and its contents. And here also the operation will be executed exactly as in ordinary cases.

Two points only deserve special mention. The intrasaccular fluid is often very abundant, and after the incision of the neck a further quantity of the same clear yellow fluid escapes from the abdominal cavity: it is tuberculous ascites, and advantage should be taken ot the open hernial channel to evacuate it completely.

Resection of the herniated omentum, studded with miliary tubercles and sometimes with larger fibro-caseous nodules, is always necessary, and an effort should be made, by drawing down the pedicle, to apply the ligature and to divide the membrane in a relatively healthy and less infiltrated portion. As a matter of fact, although the tuberculosis is usually

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[1] Garrigues, *Les hernies de la trompe utérine*. Thèse de Paris, 1904.

[2] In three cases the precise seat of the hernia was not indicated.

[3] Vaginal examination, by which the lateral inclination of the uterus and the application of the uterine cornu to the abdominal wall could be recognized, would, however, give some useful information; thanks to such an examination, M. Villard, of Lyons, was able in one case to make a diagnosis of suppurative salpingitis in an inguinal hernia sac, and the diagnosis was confirmed at the operation. (Villard, "Salpingite suppurée, dans un sac herniaire." *Bull. de la Soc. de chir. de Lyon*, juillet, 1900, p. 225.)

[4] The question of hernial tuberculosis has formed the subject of numerous monographs, and many cases have been published during the last ten years. See particularly the articles by Jonnesco, "Tuberculose herniaire." *Revue de chirurgie*, mars et juin, 1891.—P. Bruns (to which we shall refer later on).—Barozzi, *Arch. gén. de méd.*, 7 juillet, 1897, p. 85.—R. Lewisohn, "Ueber die Tuberkulose des Bruchsackes." *Mitteil. aus der Grenzgeb. der Med. u. Chir.*, 1903, xi., 5, p. 657. M. Lewisohn reports 62 cases, of which 55 were operated on, but in 5 only was the operation necessitated by symptoms of strangulation.

disseminated over the entire extent of the omentum, the herniated segment may be more largely involved, and it may even happen that the lesions are limited to the segment within the sac.

This first type of hernial tuberculosis is therefore merely an operative incident, unfortunate and disturbing certainly, but one which does not in any degree complicate the performance of the operation.

It may be very different in the **fibro-caseous type**, where there are large nodules disseminated throughout the omentum, and—still more important—extensive adhesions. We have just spoken of the ascitic form of tuberculous peritonitis in a hernia sac; here we have the other variety, an adhesive, agglutinating type, in which the work of separation is always troublesome and sometimes dangerous.

But here again the situation is simplified, up to a certain point, **when the omentum is the principal or sole seat of the lesions**: one is then at liberty to excise it widely. In a patient of von Bruns',[1] the omentum was studded with nodules, mostly caseous, of varying sizes, and was twisted in its lower part into a cord as thick as a finger, which adhered circularly to the sac in such a way as to divide the saccular cavity into two parts, of which the lower was transformed into a caseous abscess: it was necessary to sacrifice the testicle, with the sac, omentum, and abscess.

It is easy to conceive what happens when the process of adhesion and coalescence has spread from the omentum to the intestine: the typical condition of adherent hernia results, and the adhesions, which are usually dense, render the separation very troublesome because of the special friability of the intestinal wall.

The readiness with which—unless the most minute precautions are exercised—lacerations occur in the abdomen during the performance of a laparotomy for tuberculous peritonitis, or during the enucleation of a tuberculous tubo-ovarian mass adherent to the intestine, is well known.

The operator must, therefore, be on his guard against these dangers, because it will often be necessary to liberate the herniated intestine, notwithstanding the risks, the symptoms of pseudo-strangulation being in fact due to the action of the intrasaccular bands and adhesions.

(*B*). **New Growths.**—Symptoms of pseudo-strangulation may also sometimes complicate a hernia when the sac or its contents are the seat of a new growth, although here again true strangulation may occur.

Without dwelling on the subject of **hernial and peri-hernial neoplasms**,[2] to which I believe I was one of the first—in 1889—to draw attention, I shall content myself with summarizing a more recent case which will serve as an illustration.

Case 16.—It related to a man, sixty-five years of age, on whom I operated in the Saint Louis Hospital, for a large, strangulated, right inguinal hernia, the symptoms being of forty-eight hours' duration: the symptoms of strangulation were complete, including fæcal vomiting, profound stercoræmia, a very feeble pulse, and pinched face.

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[1] P. von Bruns, "Tuberculosis herniosa," *Beitr. zur klin. Chir.*, 1892, Bd. ix., 1, p. 209.

[2] Néoplasmes herniaires et péri-herniaires. *Gazette des hôpitaux*, 1889, p. 801.

I found the sac occupied by the cæcum, which was much distended and of quite abnormal appearance, and by the terminal part of the ileum. The strangulation was not very tight, and the relief of the constriction presented no difficulty. But when I came to liberate the cæcum, I found that the whole of its lower segment formed part of the wall of the sac, and that it was the seat of a large, hard, nodular tumour, which from the front could only be felt, but posteriorly could be seen, infiltrating the posterior wall of the sac. The only choice lay between making an artificial anus, and resecting the cæcum. I decided on the latter.

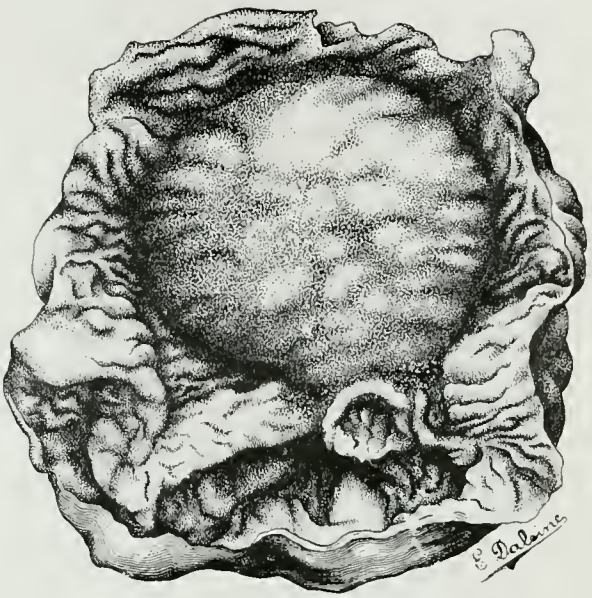


Fig. 146.—New growth of the herniated cæcum. (Sarcoma of the supra-valvular portion of the postero-internal wall.)

I separated the whole hernia *en masse*, drew the lower segment of the ascending colon and the terminal part of the ileum into the wound, and, after provisional ligation of the bowel with two strips of gauze, I performed enterectomy and anastomosed the ileum to the cut end of the colon, after having reduced the calibre of the latter by suturing one of its angles; the ileo-colic loop was then reduced, and the operation completed in the ordinary way. The specimen is shown in *Fig.* 146. The patient, despite his apparently hopeless condition, stood the operation very well, and lived for three days under conditions which made us hope for a successful result; he had passed flatus, vomiting had ceased, and all abdominal reactions had disappeared. Unfortunately, the pulmonary congestion, which had been present at the time of the operation, persisted, and finally became general, and carried him off. At the autopsy, the suture line was found intact, and the adjoining region perfectly dry; there was no trace of peritonitis, but both lungs were consolidated.

These cases are, however, very uncommon, and fortunately so, because almost invariably they necessitate resection of the hernial neoplasm under particularly unfavourable circumstances.

IV.—HERNIÆ TRANSFORMED OR COMPLICATED BY PRECEDING TAXIS.

This is a condition which not uncommonly presents itself in practice. A hernia has been reduced by taxis, perhaps the surgeon has reduced it

himself: some hours later he is again summoned to see the patient; the symptoms of strangulation still persist, the pain and vomiting still continue, the distention is increasing, and the septic intoxication is becoming pronounced. What has happened? What is to be done?

One or other of several occurrences has taken place: it is necessary to be acquainted with these possibilities, and the cause of the *continued strangulation* must be studied; but face to face with the

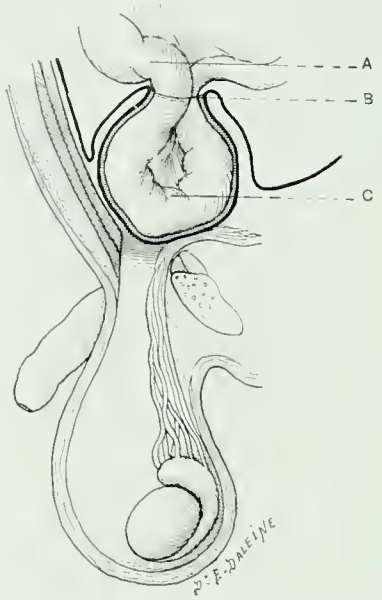


Fig. 147.—Reduction *en masse*. (A) Upper end of the strangulated loop. (B) Constricting ring, reduced along with the sac. (C) The strangulated loop and the sac pushed *en masse* above the internal ring.

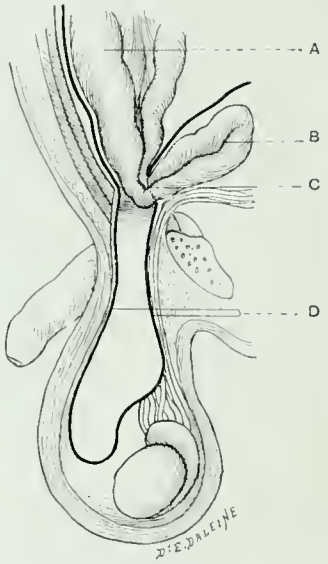


Fig. 148.—False reduction by rupture of the sac and displacement of the intestine into the extraperitoneal cellular tissue. (A) Upper end of the strangulated loop. (B) Loop displaced through the tear in the sac into the extraperitoneal cellular tissue. (C) The tear in the sac. (D) The empty sac.

actual emergency, no time must be lost in striving to come to a precise diagnosis, which is, indeed, very often impossible, and recourse must be had forthwith to the intervention which we shall describe immediately.

(*A*). The only result of the taxis has been the **reduction en masse** of the hernia; in other words, the sac and its contents, without alteration of their mutual relationships, have been pushed back together through the inguinal canal, and the internal ring into the extraperitoneal cellular tissue: the hernia has become properitoneal, and *remains strangulated* (*Fig.* 147).

Sometimes the displacement has affected only the neck and the upper part of the sac, and the fundus still occupies the inferior segment of the hernial track.

(*B*). The taxis may have properly mobilized and displaced the contents of the sac, but instead of re-entering the free abdominal cavity,

they have been pushed into a diverticulum of the sac, some pocket in the vicinity of the neck (properitoneal usually), and ready to become the seat of fresh incarceration. Some writers indeed are of the opinion that the majority of the so-called reductions *en masse* which we have just mentioned are really cases of reduction into a pre-existing pocket. However that may be, the result is practically the same, and the treatment ought to be the same.

(*C*). By forcible taxis the sac has been torn, ruptured above the neck, and the intestine has been pushed through the gap into the extraperitoneal cellular tissue while still remaining strangulated (*Fig.* 148).

This is a very uncommon accident, and can of course only be diagnosed during the course of operation.

(*D*). Another exceptional accident may occur : under repeated and forcible pressure, the neck tears circularly, separates from the rest of the sac, and the intestine is pushed back into the abdominal cavity, but still surrounded by the constricting ring, which re-enters with it (*Fig.* 149). Then an internal is substituted for the hernial strangulation.

(*E*). Lastly, although the contents of the hernia may have been properly and effectually reduced, the intestine becomes kinked, twisted, or strangulated anew in the neighbourhood of the internal ring, under an epiploic band adherent to the neck of the sac ; or again, the loop of intestine, after reduction, remains flexed, kinked, or folded by the adhesions, just as it was within the sac, and the obstruction persists (*Fig.* 150).

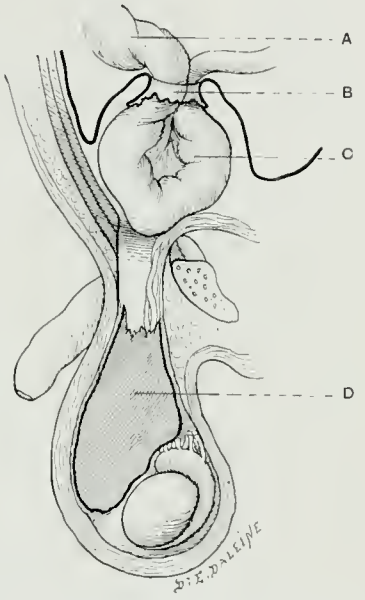


Fig. 149.—False reduction by circular rupture of the sac below the neck. (A) Upper end of the strangulated loop. (B) Neck reduced with the strangulated loop, and maintaining the strangulation. (C) Strangulated loop. (D) The empty sac.

Is it possible to make the diagnosis of one or other of these conditions : that is, is it possible to recognize the cause of the continued strangulation ? In the majority of cases, no. In the event of reduction *en masse*, or into a diverticulum, when the imperfectly reduced loop remains in contact with the deep inguinal wall, it is possible on palpation to discover the tense, rounded, fixed swelling which we mentioned when speaking of properitoneal hernia ; at the bottom of the inguinal canal or behind the wall towards the iliac fossa, or towards the hypogastric region, a larger or smaller mass may be felt, distinguished from the neighbouring abdominal territory by its consistence and dullness. This, taken in conjunction with the functional symptoms, affords a valuable sign, although its exact interpretation is always a little doubtful. But even in the absence of any

definite physical sign, the persistence of the symptoms of acute strangulation commands operation without delay.

Two routes present themselves under these circumstances: **the inguinal incision, extended**, if necessary, and as far as may be necessary, into the abdominal wall—that is, a hernio-laparotomy or **primary median laparotomy.** In the majority of cases, and particularly when supra-inguinal palpation has revealed the presence of a suspicious swelling, there are decided advantages in following the technique of an ordinary herniotomy, which, as a rule, provides more direct access to the site of the *continued strangulation*, makes the operation more simple, less dangerous (at least in urgent surgery and when resources are limited), and lastly, may be completed by excision of the sac and a radical cure.

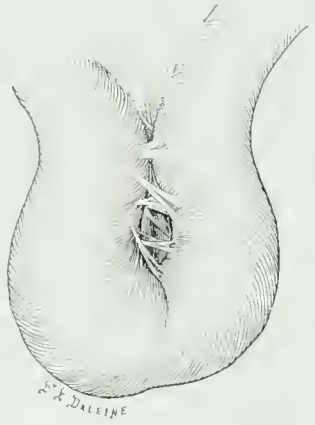


Fig. 150.—Two limbs of a loop of intestine, fixed together by adhesions like the double barrels of a gun.

The first step, therefore, is to open the inguinal canal by incising its anterior wall: if it is empty, the sac and its contents have been reduced *en masse*; or it may contain the empty sac.

In either case, the internal ring must be incised for a sufficient extent to allow of an adequate digital and ocular exploration of the surroundings of the hernial region; and there must be no hesitation in providing a sufficiency of room in order that the lesion may be recognized at once and satisfactorily treated. Free access is of capital importance; and though it may sometimes happen that the neck of a properitoneal or displaced sac, situated very low down and quite close to the internal ring, may be incised without difficulty, still even then the strangulation ought only to be relieved under visual guidance; the dangers incurred in blindly seeking and breaking down what is supposed to be a band, or the neck of the sac, within the free abdominal cavity, and in the midst of distended coils of intestine, will be readily understood.

The inguinal incision will therefore be carried upwards and outwards as far as may be necessary; particularly upwards, parallel to the outer border of the rectus muscle and as close to it as possible. Liberate the intestine and excise the deep sac: these are the two chief features of the programme, which will be completed by careful closure of the inguino-parietal wound.

Median laparotomy is indicated in cases where there is ground for supposing the existence of secondary internal strangulation, where the examination of the inguinal and supra-inguinal regions has given entirely negative results, and lastly, in all conditions where the symptoms of obstruction are definite but the cause is uncertain.

Taxis may be followed by other complications : it may reduce *intestine which is in process of perforation*,[1] *or already perforated*, *gangrenous omentum*, *very septic sac fluid* which, even in the absence of any intestino-omental lesions, may suffice to inoculate the peritoneum and to give rise to generalized peritonitis.

We shall then have to deal with peritoneal infection, usually of the hypothermal, the most dangerous, type ; the necessary treatment is identical with that of any other intestinal perforation : median laparotomy. Search for the perforated loop, close the perforation or perforations, irrigate and drain. It is needless to insist on the gravity of the prognosis ; we have only one method of lessening that gravity : operation, performed early and rapidly.

Two other complications which, apart from any strangulation, may necessitate immediate operation, also require mention : (1) Serious contusion of a hernia, giving rise to symptoms of hernial peritonitis, or even followed by rupture of the intestine. I saw a man die in the Beaujon hospital who had fallen from the fortifications and injured a large right inguinal hernia ; at operation I had found a perforation of the intestine and generalized purulent peritonitis ; (2) Spontaneous rupture of the coverings of the hernia, followed by evisceration of the contents : this is a very uncommon accident (Mme. Katz-Tchébycheff has collected 24 cases in her thesis, *De la rupture spontanée des enveloppes herniaires*, Paris, 1901, No. 431), which usually implies a gradual preceding thinning of the skin and follows a violent effort, a fall, etc. : the intestines protrude through the opening. After the sac has been laid freely open, the contents must be carefully cleansed and reduced, and the inguinal wall carefully repaired

We shall add only a few words regarding the **accidents which may occur during or after herniotomy** and complicate the operation or the after-course : they have been for the most part already mentioned in the description of the operative technique. We shall only consider the following :

1. **The wounding of an artery of some size**, in the vicinity of the neck of the sac, the deep epigastric for instance : this was a serious accident when the old custom of a hidden incision of the constriction was followed, but is comparatively unimportant when the open operation is performed : if necessary the abdominal wall is compressed by means of one or two fingers introduced into the abdomen through the incised neck of the sac, while the two ends of the cut vessel are sought for and tied.

It is necessary to know, however, that these arteries are very retractile, and tend to slip away into the very lax connective tissue of the region, where the blood accumulates and forms a diffuse hæmatoma : it is absolutely necessary to look for the retracted end, and check the bleeding by direct ligature.

[1] The perforation may be completed by the manipulations.

2. **Wounding of the intestine**, in opening the sac; perforation of a diseased and friable intestine during separation or reduction: these accidents demand immediate repair of the lesions, followed by careful cleansing.

3. **False reduction**, or the pushing of the intestine into the extra-peritoneal cellular tissues through the incision made for the relief of the constriction (*Fig.* 151). There is no chance of this happening when the incision is sufficiently large, when the operator sees what is being done, and the reduction is effected under his eyes, and when, before proceeding to incise the sac, the whole abdominal prehernial zone is carefully explored with the finger. It manifests itself by the persistence of the symptoms of intestinal obstruction, and necessitates a hernio-laparotomy as speedily as possible.

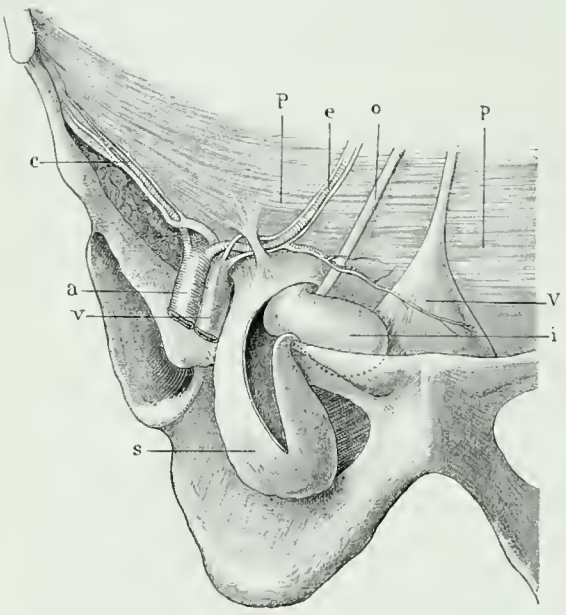


Fig. 151. False reduction after incision of the neck of a femoral hernia. The intestine (i) is lodged between the pubis and the peritoneum (PP), of which the anterior surface is seen. (V) Bladder. (o) Obliterated hypogastric artery. (e) Epigastric vessels. (c) Circumflex vessels. (a and v) Femoral artery and vein. (s) Hernial sac, opened, its neck incised and empty, but still strangling the intestine. (Farabeuf.)

4. **Bleeding from the depths of the wound**, in fairly considerable amount, after an apparently straightforward reduction. In such circumstances it is necessary to see where the blood is coming from, particularly if any omentum has been ligated and resected. As a matter of fact, the hæmorrhage may come from *an omental stump*, badly tied, or on which the ligature has partly or completely slipped; or again, from *an omental fringe* which had not been included in the ligature, but had been cut with the rest; from *a laceration of the intestine* caused during reduction, or from *a tear in the mesentery* which had passed unnoticed, on the folded and infiltrated membrane in the sac, but which began to bleed again as soon as it was restored to the abdomen and able to resume its shape.

Wherever the source of the hæmorrhage may be, the wound must be enlarged if necessary, and a search made for the viscera which had just been reduced (and which are usually close at hand), and whatever is necessary will be done. *A hernial sac must never be ligated if it is not absolutely dry.*

or if a gauze swab pushed into the abdomen through the orifice is stained with blood when withdrawn.

5. **Secondary peritonitis,** with or without perforation, creates urgent indications which we have already discussed.

6. Lastly, after herniotomy, as after taxis, **paralytic ileus** may occur, particularly in old or feeble patients, and most often in cases with large hernias.

Sometimes it arises without any recognized cause. The evolution of the symptoms is then less rapid and less immediately grave than in the cases of false reduction mentioned above: there is usually a period of quiescence, a remission at least in the pain, and it is not until after twenty-four or thirty-six hours that the persisting inability to pass either fæces or flatus, the return of the vomiting, and increasing abdominal distention, indicate the intestinal obstruction.

The condition is serious, and the necessary measures cannot be instituted too soon: in such a case an electric enema should first be tried (see INTESTINAL OBSTRUCTION); if this fails, laparotomy is necessary, the more so since some doubt nearly always exists with regard to the actual cause of the secondary pseudo-obstruction.

True ileus may also occur, and at varying periods. When immediate, it is included with the continued strangulation which we have described on page 202; at other times it ensues when healing is complete, after a time which may vary from weeks to months; strangulation in the vicinity of the former neck of the sac, by an omental band or by adhesions; kinking of the formerly herniated loop of intestine, the two limbs of which have remained bound together like the double barrels of a gun (*Fig.* 133); and multiple adhesions in an area of chronic peritonitis are the most common causes. We must also mention *delayed* obstruction, developing at a very distant date, from one to several years, and due to intestinal stenosis consecutive to ulceration, and often associated with adhesions.[1]

Another accident may, though rarely, follow reduction of the strangulated hernia by either herniotomy or taxis: *intestinal hæmorrhage.* It may be early or late. In the former case, bloody stools appear within a few hours after reduction, and are repeated at longer or shorter intervals for two, three, four, or five days. The loss of blood is sometimes comparatively slight, the motions containing merely a few clots, but it may be very profuse and produce a very grave condition. A patient of M. Preindlsberger's[2] was operated on for a strangulated inguinal hernia: a blackish loop of small intestine was found in the sac, but its serous coat was smooth and glistening, and it was therefore reduced. During the first night there were four bloody motions; on the following day another profuse intestinal hæmorrhage. Death occurred from collapse on the fifth day. At the post-mortem examination, a segment of ileum about

[1] See our report on a case of this kind operated on by M. Souligoux. Des rétrécissements tardifs de l'intestin, consécutifs à l'étranglement herniaire. *Soc. de chir.*, 8 mars, 1905, p. 261.

[2] PREINDLSBERGER, Ueber Darmblutungen nach Reposition incarcerirter Hernien. *Wiener klin Woch.*, 1901, No. 14.

seven feet in length was found, dusky, chocolate-coloured, and with its mucous membrane sloughing and ulcerated. When it occurs late, the intestinal hæmorrhage appears from the fifth to the tenth day, and without doubt is often due to ulceration consecutive to the separation of sloughs. In practice, it will always be well to remember the possibility of these accidents, and to examine the stools during the days succeeding any operation for strangulated hernia: application of ice to the abdomen, chloride of calcium internally, and the administration of saline solution in large quantities, constitute the chief elements in the treatment; if the hæmorrhages recur in alarming quantity and are associated with symptoms of pseudo-obstruction, laparotomy will be indicated, followed by resection of the thrombosed intestinal segment.[1]

STRANGULATED FEMORAL HERNIA.

Operate early, particularly in the small hernias. Even if the obstruction is not complete and some flatus is still passed, it must not be forgotten that lateral strangulation (Richter's hernia) occurs most frequently in the femoral region. A simple epiploitis on the one hand, and, very exceptionally, inflammation of a lymphatic gland on the other, may simulate a strangulated inguinal hernia; but when in doubt do not wait to make a definite diagnosis; operate at once. In addition to its ordinary dangers, taxis cannot be very systematically applied in this region; it can only act by direct pressure, and tends to cause reduction *en masse*. Further, the strangulation is usually very tight, and the intestine, kinked over the sharp edge of Gimbernat's ligament, is in a condition which predisposes to the rapid occurrence of gangrene.

Operate at the earliest possible moment, and then the operation will generally be comparatively simple.

The usual preparations are made, as above (see SIMPLE STRANGULATED INGUINAL HERNIA); the operation area is shaved, cleansed, and surrounded with sterile towels.

Incise the skin along the chief axis of the hernial swelling (*Fig.* 153); in other words, in the majority of cases make an incision parallel to Poupart's ligament, with its centre over the most prominent part of the swelling and extending beyond its borders on either side. Personally we prefer this oblique incision to the classical vertical one; it facilitates the isolation of the sac, provides freer access to the ring, and is better adapted to the radical cure which terminates the operation.

The vertical incision should be reserved for those cases where a large, nodular swelling descends well below Poupart's ligament. But, after all,

[1] M. Sauvé has collected 28 cases of these post-hernial enterorrhagias, and discusses the causation. ("Des hémorragies intestinales consécutives à l'opération des hernies en général." *Revue de chir.*, 1905, i., p. 211.)

it does not matter very much which incision is used; whether the skin is incised longitudinally or transversely, the important point is to make the opening sufficiently large to allow of the manipulations being easily carried out.

1*st step*.—**Isolation of the Hernial Sac, like a Tumour, without opening it.**—There is not much advantage in picking up a fold of skin before incising it; steady the skin with the fingers and the thumb of the left hand and incise it directly; then cautiously divide the underlying fibro-fatty layer, of variable thickness, in which run several veins, tributaries of the internal saphenous.

The hernial sac, or at any rate its outer coverings, now comes into view; commonly it is surrounded by a thick layer of fat. Sometimes, indeed, there is an *actual lipoma*, which forms a tumour below and in front of the sac, and which it is advisable to separate and excise forthwith. Under this layer of fat, or sometimes immediately under the skin in very thin patients, the sac proper appears, tense, reddish or blackish in colour, like a large blood-cyst; at other times it is nodular, polycystic, and of a very peculiar appearance.

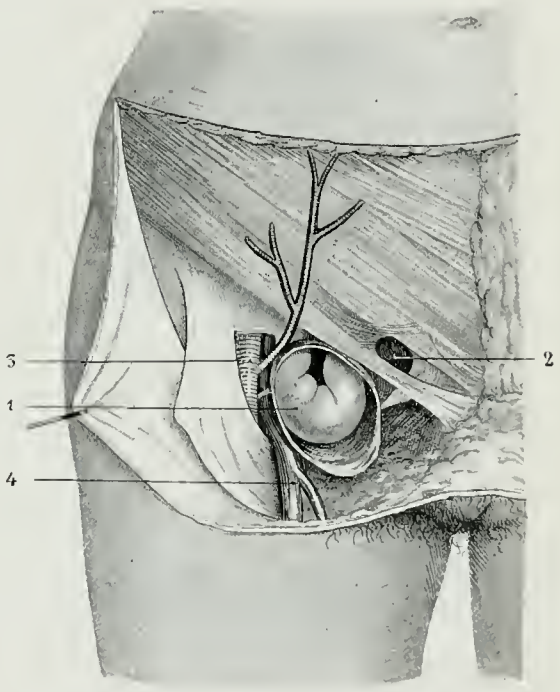


Fig. 152.—Relations of a femoral hernia (Le Fort). (1) The loop of intestine in the opened sac; (2) The external inguinal ring (3) The femoral artery; (4) The femoral vein.

In any case, however, **do not open the sac directly it is exposed, but proceed to separate it completely, like a tumour.** Free its border with the fingers, then separate and turn up its posterior surface (*Fig.* 154), and continue the enucleation right up to the neck, which can be seen quite definitely emerging from the femoral ring. If the correct tissue plane about the sac has been reached, this blunt dissection can be executed without difficulty, and the serous bursæ which often envelop it help to make the enucleation easy.

This preliminary step greatly facilitates the subsequent manœuvres;

the sac is completely isolated and perfectly free, and there is no difficulty in reaching its neck, the surrounding fibrous ring, and Gimbernat's ligament, which can be easily and completely exposed with the end of the grooved director, and forthwith incised in full view of the operator, if necessary.

2nd step.—**Opening the Sac. Examination of the Contents. Relieving the Constriction.**—Now open the hernial sac, after having slipped an aseptic pad of gauze underneath it. Remember that though the cavity of a femoral hernia sac is usually simple, its wall is generally thick and not infrequently complex. Fatty tissue intermixed with layers of fibrous tissue, serous bursæ, and irregular cystic cavities, sometimes filled with blood, enter into its formation and increase the number of its layers; at some points they may give it a compact, fleshy, striated appearance which makes one think of intestine, and as a matter of fact the cæcum may slip down into and form part of the sac wall in these femoral hernias, or, in an old-standing case, the intestinal wall may have become continuous with the sac wall.

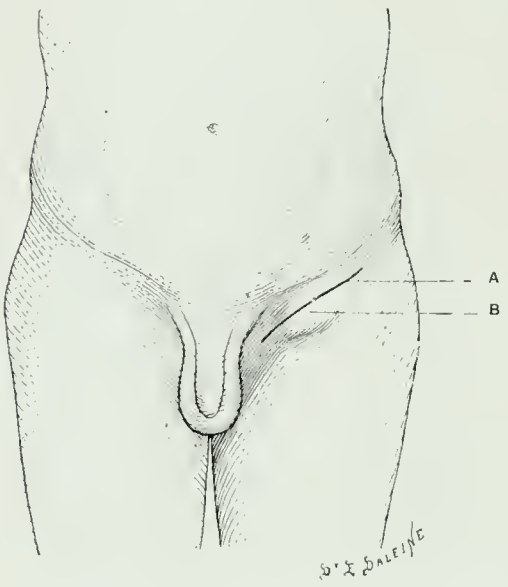


Fig. 153.—Femoral herniotomy. Line of the incision parallel to Poupart's ligament. (A) The incision. (B) The prominence of the hernial swelling.

It is necessary, therefore, to **proceed cautiously, dividing the successive layers one by one on the director**; some reddish fluid may escape, but that does not necessarily mean that the sac has been opened; therefore examine the cavity well; it is sometimes only a closed, narrow space without an outlet towards the abdomen, a mere cystic pocket; go on dividing, and remember that, here again, as long as there is any doubt, the sac has not been opened. **Pick up the deeper layers in folds with the dissecting forceps, before dividing them**; the preliminary isolation of the hernial swelling greatly facilitates these manœuvres.

Once the sac has been opened, extend the incision upwards and downwards, secure the edges with forceps, and proceed to **the examination of the contents.**

In most cases, particularly in small hernias, there will be found at

the bottom of the cavity—perhaps covered with a thin layer of omentum—a small, black, tense, and tightly constricted loop of small intestine. Of course the contents are as variable as those of an inguinal hernia, and large femoral hernias are met with, containing a large mass of omentum, several loops of small intestine, and the cæcum or sigmoid colon; this is, however, exceptional, the former type being commoner.

Whatever the contents may be, *bathe them with warm boiled water and cleanse them carefully* before proceeding to enlarge the neck of the sac and to draw down the pedicle of the herniated segment.

I say "to enlarge the neck of the sac" advisedly, because the constriction may be overcome and the obstruction removed in various ways, and an incision with a cutting instrument is by no means always necessary.

Plate V shows very well the general arrangement in the zone of strangulation; in practice, the obstacle lies to the inner side, either at the level of the cribriform fascia or, more deeply, at Gimbernat's ligament; **it is always to the inner side that the attention must be directed.**

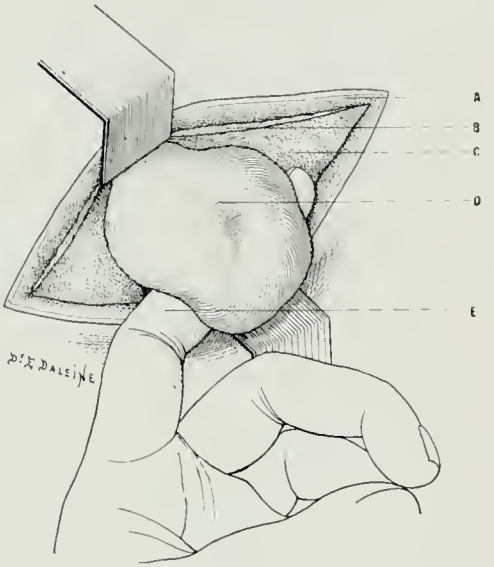


Fig. 154.—Femoral herniotomy. Isolation of the sac, before opening it, like a tumour. (A) Subcutaneous fat. (B) Deep fibrous layer of superficial fascia. (C) Peri-saccular region. (D) Sac isolated unopened. (E) Finger liberating and raising the sac.

The strangulation appears to be situated, in a comparatively large number of cases, in the fibrous ring of the cribriform fascia, through which the hernial sac comes forwards to show itself under the skin. In recent and typical cases it may be possible to recognize in succession from within outwards *a deep ring* situated to the outer side of Gimbernat's ligament; *a track*, corresponding to the inner compartment of the femoral sheath; *a superficial ring* which is merely one of the orifices of the cribriform fascia; an *external subcutaneous portion*, more or less developed, which sometimes extends upwards in a curved direction to or even above Poupart's ligament.

During the performance of a radical cure, when the hernia is small or of moderate size, these anatomical conditions may be readily recognized and the various steps defined. As to the strangulation, it is usually situated at the *superficial cribriform ring*, or at *the deep femoral ring*, more often perhaps at *the former site*, but it is usually rather difficult to define the exact localization. Practically, it is always best to effect the

digital stretching or to make the incision of the constriction in an inward direction, and to continue it from before backwards as far as may be necessary to open up the channel.

The following plan often succeeds, and is always worth a trial: *pass the right index finger along between the inner side of the sac and its contents*, right up to the neck (*Fig.* 155), while the anterior wall is lifted up with a retractor, and try, by gently pushing the intestine aside, to insinuate the tip of the finger past the margin of the tense fibrous ridge. In this way

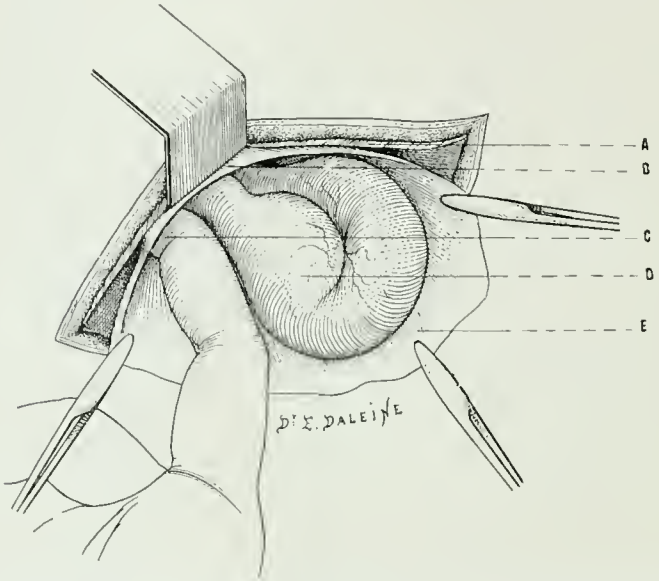
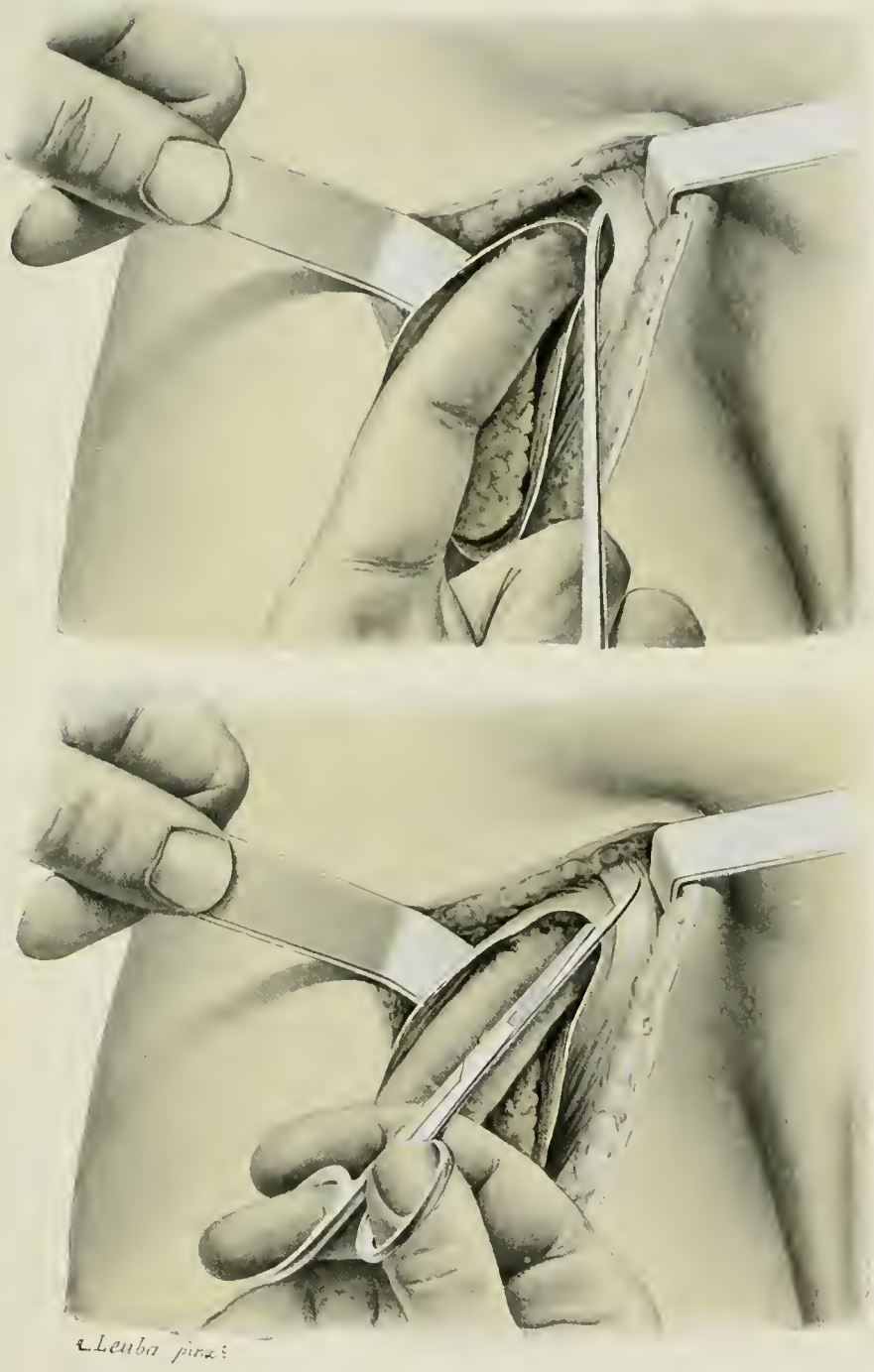


Fig. 155.—Femoral herniotomy. Enlarging the neck of the sac, by stretching with the finger. (A) Deep layer of the superficial fascia. (B) Anterior wall of the sac. (C) Index finger being insinuated at the inner part of the neck and stretching the constriction. (D) The herniated loop. (E) The opened hernial sac.

one may often succeed in bringing the pulp of the finger to bear against the inner border of the neck; then, by flexing the distal phalanx and by exercising traction in an inward direction, towards the pubes, it may be possible to stretch or rupture the fibrous band, and so enlarge the opening sufficiently to allow of the intestinal loop being drawn down.

Whether the resistance is due to the neck of the sac or of the ligament outside the sac, matters little; if the end of the finger can be introduced, the pressure is applied against everything that resists, and breaks down the constricting band. We have often employed this method of dilating the neck of the sac when operating on strangulated femoral hernias.

Plate V.—**Femoral Herniotomy.** In the upper figure, a grooved director raises the fibrous margin of the ring, which can be divided separately. In the lower figure, the constriction is being relieved by simultaneous section, on the finger, of the fibrous ring and the neck of the sac.



FEMORAL HERNIA

But possibly the finger cannot be introduced; the desired result may be obtained, it is true, by using the closed blades of a pair of blunt, curved scissors or a curved director instead of the finger, but the method is then neither so simple nor so safe, and it is much better to relieve the constriction by a regular incision.

Here again, the operator should accustom himself to making **the open incision,** in order that he may see what he is about to cut, and to make a careful dissection rather than a sort of blind tenotomy.

Draw the inner wall of the sac outwards, clear the inner aspect of the neck thoroughly, and expose the fibrous margin of the ring, which should be seen, if the wound is sufficiently large and well retracted, as plainly as in a dissection on the dead subject (*Plate V*).

Raise the fibrous margin with a director or the end of a forceps, and incise it with the knife or scissors (*Plate V*); if the ring is too intimately associated with the neck of the sac to allow of any instrument being slipped between them, incise it directly from before backwards. When the incision has been started, one may, if preferred, for safety's sake, enlarge it with the finger or the grooved director.

When performed in this way, the section of Gimbernat's ligament is a simple and safe procedure, and if by chance an artery of some size runs along its internal border (one of those anastomotic arteries joining the deep epigastric to the obturator, which have been quite wrongfully, on the strength of some exceptional observations, converted into a sort of bugbear), and should be injured, the accident is no more serious than if it had occurred on the surface of an open wound; the two bleeding points are under the surgeon's eye, and to catch and tie them offers no particular difficulty.

As soon as the obstacle has been overcome, carry the finger to the interior of the neck of the sac, which as a rule allows itself to be dilated without difficulty, and provides free access to the pedicle of the hernia. If the neck should be thickened and contracted, and still offers some resistance, nothing is simpler than to prolong the incision in the sac through it after having pulled it down; care must be taken to secure the upper angle of the incision at once with forceps, so that it may afterwards be drawn down sufficiently to form a satisfactory pedicle.

As a matter of fact, by either method the enlargement of the constricting ring is easy and safe; I may say, however, that in some very fat women, when the strangulation is situated very high and is very tight, it may be more expeditious to have recourse to the old practice of **using the probe-pointed hernia knife.** Still, by extending the incision inwards, by excising the fat (there is nothing to fear on the inner side of the hernia, as the large vessels (*Fig.* 152) lie externally and behind), and by strongly retracting the edges of the wound, it is always possible to provide sufficient access and to avoid the necessity of incising the constriction blindly, with the finger as the sole guide.

The left index is slipped, as before, along the inner surface of the sac, up to the neck, which it cannot pass. Opposite this it pushes aside and

protects the intestine; along this finger, which serves as a guide and retractor, a Cooper's knife is carried on the flat past the inner border of the neck, and its cutting edge is then turned inwards and the constriction nicked. An extensive incision is quite unnecessary; let it be sufficient to allow the tip of the finger to enter, and stretching will do the rest. In some cases the constriction may be relieved by an extra-saccular incision (*Fig.* 156).

3rd step.—**Reduction. Radical Cure.**—The obstacle has now been removed; draw out the omentum and intestine, examine the constricted portion, resect the omentum after ligature (following the technique already detailed), and if the intestine is intact, reduce it. We shall see later what treatment is necessary in dealing with gangrenous intestine.[1]

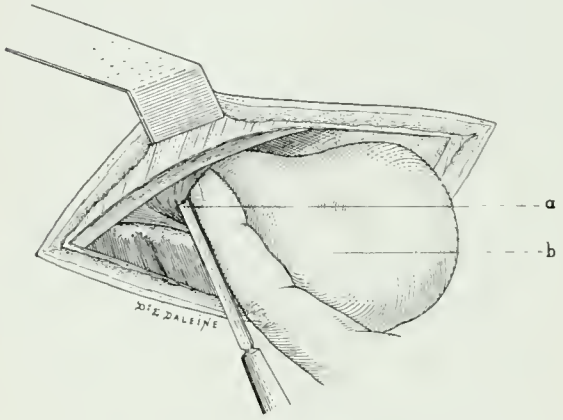


Fig. 156. Relieving the constriction of a femoral hernia by extra-saccular incision. (*a*) Probe-pointed hernia knife incising Gimbernat's ligament, while the index finger pushes aside and protects the sac. (*b*) The hernial sac.

It then only remains to tie and resect the sac and to close the hernial orifice in the best manner possible. The preliminary isolation of the sac, "like a tumour," which formed the first step of the operation, makes this last part very easy. Here again, care must be taken to draw the neck of the sac down as far as possible and to free it from the extra-peritoneal fat, which must be pushed aside with a bit of gauze, especially on the inner side, where a large mass of fat will always indicate the need for caution and cause the operator to think of a prolapsed bladder.

The pedicle of the sac is ligated like that of an inguinal hernia. (See *above*.)

The femoral ring still remains to be closed in order to effect a radical cure in so far as it is possible; this, however, in an operation for strangulated hernia, is only a step of secondary importance, particularly as the work of repair cannot be by any means so satisfactorily executed as in the inguinal region.

Still, if the operation has not lasted too long, and the condition of the

[1] We have already described the method of treating a hernia with abnormal contents (see COMPLICATED INGUINAL HERNIA). In a femoral hernia, though less commonly, the large intestine, the bladder, the appendix, and the ovary may also be met with.

patient permits, it is well to complete as follows: Expose the bottom of the wound on the inner side by separating the fat with the grooved director and retracting it; there is then no difficulty in recognizing the fibres of the pectineus muscle through its thin fascial covering. Expose the fascia up to the horizontal ramus of the pubes, where the membrane becomes thicker and stronger (Cooper's ligament).

This pectineal fascia is to be sutured to the lower border of Poupart's ligament, or rather to the fibrous lamella attached to, and extending down from, that border, and forming the upper part of the cribriform fascia.[1] This layer cannot be so satisfactorily defined and dissected up as in an ordinary operation for radical cure; still, a segment sufficient for suturing to the pectineus will fairly often be found attached to the lower border of the ligament. A curved Reverdin needle is passed through this sub-inguinal lamella, or if necessary through the lower border of the ligament itself, which can sometimes be pulled down; on the other hand the needle picks up the pectineal fascia, as close as possible to its attachment to the bone, and a good thickness of the muscle tissue; in this way a series of interrupted sutures is passed (*Fig.* 157). It is advisable to place the sutures a little obliquely, because they then include more tissue and have less tendency to cut out; or again, instead of interrupted sutures, a continuous suture with closely placed stitches may be used.

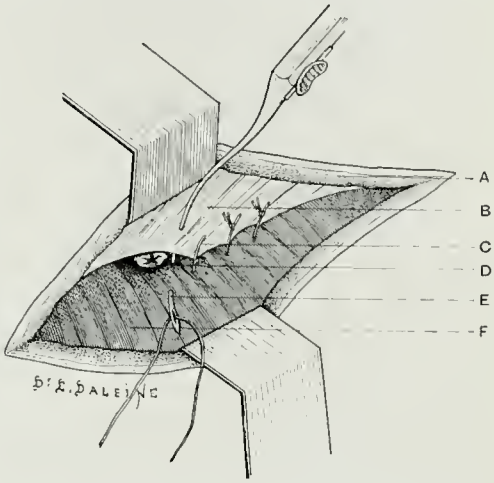


Fig. 157. — Femoral herniotomy. Closing the ring; suturing the sub-inguinal fascia to the pectineal plane. (For the sake of clearness, the pectineal fascia is not shown.) (A) Subcutaneous fat. (B) Lower margin of Poupart's ligament and the layer of fascia which extends downwards from it. (C) Suturing this layer of fascia, by interrupted sutures, to the pectineus muscle and fascia. (D) Neck of the sac, tied. (E) Needle picking up a good thickness of the pectineal plane. (F) Pectineus muscle.

If the subinguinal lamella is fairly thick, it is better to divide it by a vertical incision—which encroaches a little on Poupart's ligament—into two flaps, which are turned down and sutured to the pectineal fascia and united together by their bases (*Fig.* 158).

[1] This is Lucas-Championnière's method, described by A. Termet in his thesis ("Considérations sur la hernie crurale, sa cure radicale par le procédé de J. Lucas-Championnière, 1898"). The upper segment of the cribriform fascia, immediately below Poupart's ligament, almost always forms a lamella of some thickness, and is sufficiently well defined to be easily recognized and preserved during the first step of the operation; it is this sub-inguinal lamella which is to be turned down like a cover in front of the femoral ring and sutured to the pectineal plane.

With some care, the femoral ring can be closed and a complete covering provided for the orifice. During this whole proceeding the great vessels should be retained in the outer angle of the wound with a retractor.

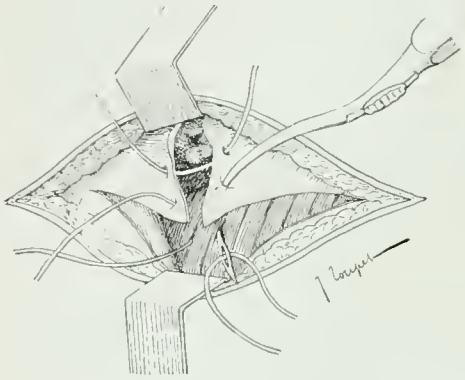


Fig. 158. Femoral herniotomy. Radical cure (Lucas-Championnière's method). The sub-inguinal fascia, split into two flaps, is turned down in front of the ring and sutured to the pectineal plane.

The first sutures must not be placed too far outwards, and the posterior plane, the pectineal, must be very carefully defined and the tissues definitely recognized before the needle is passed through them. Moreover, it is especially at the inner side that the suturing is useful.

Occasionally the sub-inguinal lamella is retracted, torn, and useless, and then it is most convenient to pull down Poupart's ligament itself, employing either Berger's or Delagenière's method.

In Berger's method, the first suture is passed from within outwards through the thickness of the pectineus as near as possible to its upper attachment; it emerges at the outer border of the femoral canal, almost in contact with the femoral vein, which is carefully retracted; it is then carried from without inwards in the lower margin of Poupart's ligament, so forming a circular loop, which, when the two ends are tightened and knotted, approximates the ligament to the horizontal ramus of the pubes. Over the first suture a second and a third may be introduced in the same manner, each successive one being lower down on the pectineus and higher up on the ligament (*Fig.* 159.)

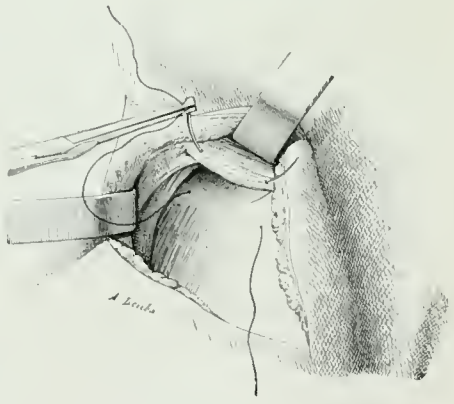


Fig. 159.—Femoral herniotomy. Radical cure (Berger's method).

In Delagenière's method, Poupart's ligament is first incised at right angles to its lower margin; stout sutures are passed through the angles of the two flaps, and then through the thickness of the pectineus muscle and the ileo-pectineal band (*Fig.* 160); thanks to the preliminary incision, the two flaps can easily be drawn down, but they remain separated by a small triangular space when the sutures are tied.

Here again, though always desirable, it is by no means essential to complete the operation in this manner; sometimes, indeed, the friability and the fatty infiltration of all the tissues render any attempt at suture quite valueless. Still, and particularly if it has been necessary to incise freely the constricting ring, try to bring the tissues together by a few sutures introduced at the inner angle of the ring, and after excising any redundant tags of fat, suture the skin without drainage.

A large dressing, well covered in and secured by a double spica, is necessary in this case also.

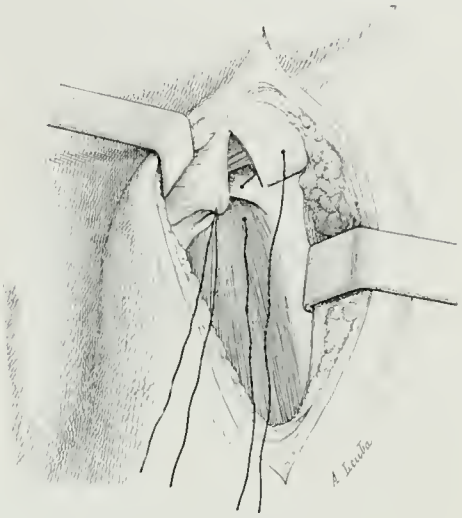


Fig. 160.—Femoral herniotomy. Radical cure (Delagenière's method).

Such is the typical operation in a case of femoral hernia. Other difficulties will sometimes be met with; the surgeon may have to deal with a complicated hernia similar to those which we have already studied in relation to inguinal hernia, and to which we refer the reader.

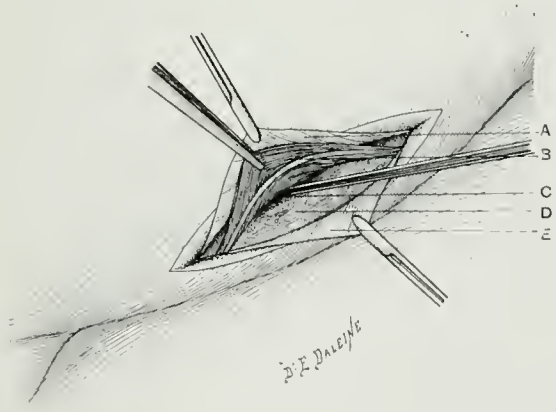


Fig. 161. Operation for femoral hernia by the inguinal route; 1st step: *Opening the inguinal canal, raising the cord and the lower border of the muscles.* (A) Upper edges of the aponeurosis of the external oblique. (B) Lower border of the internal oblique and transversalis muscles. (C) Grooved director separating and raising the muscles. (D) Deep wall of the inguinal canal. (E) Lower edge of the aponeurosis of the external oblique.

We shall merely mention some **rare forms of femoral hernia**: *the external femoral hernia*, in which the sac, in place of occupying the inner compartment of the femoral sheath, lies in front or to the outer side of the femoral vessels; *Laugier's hernia*, through Gimbernat's ligament; the *pectineal* or *Cloquet's hernia*, which, after having emerged by the femoral canal, passes through a deficiency in the pectineal fascia and burrows between the fascia and the

pectineus muscle, and so, developing deeply, simulates the appearances of an obturator hernia; *Hesselbach's hernia*, in which the sac is prolonged in multiple diverticula through orifices in the cribriform fascia. It is necessary to be aware of the possible occurrence of these unusual varieties; but practically, if the various operative steps are systematically followed, and particularly if care is taken to isolate properly the sac and its neck, they may cause some surprise but no real difficulty.

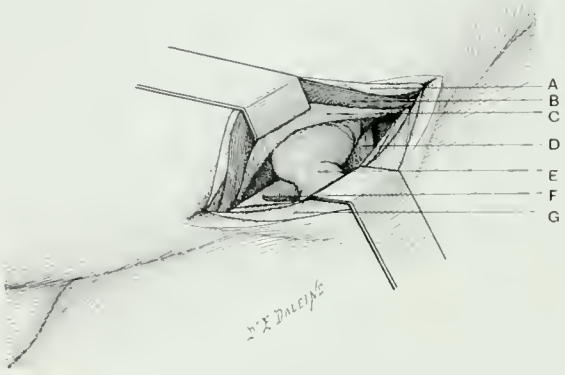


Fig. 162.—Operation for crural hernia by the inguinal route. 2nd step: *The posterior wall of the canal being opened, the neck of the femoral sac is exposed in the extra-peritoneal cellular tissue.* (A) Upper edge of the external oblique aponeurosis. (B) Internal oblique and transversalis muscles, retracted. (C) Deep wall of the inguinal wall (fascia transversalis) incised. (D) External iliac vein. (E) Neck of the femoral sac. (F) Gimbernat's ligament. (G) Lower edge of the external oblique aponeurosis.

There is one technical point which requires special mention: in the presence of a deep-seated femoral hernia presenting in front of the peritoneum, or a hernia of the bladder or the cæcum, or, generally, **in any case where it is necessary to provide freer access** and to transform the herniotomy into a hernio-laparotomy, what is the best method of providing it, and in what direction should the femoral ring be enlarged? An incision outwards is quite impossible, because it would invade the vascular region; **the additional incision can only be made in an upward direction.**

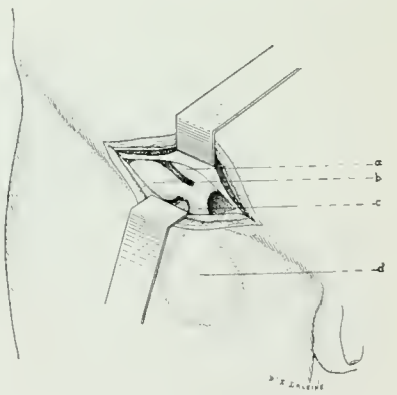


Fig. 163.—Operation for femoral hernia by supra-inguinal incision, in a case of properitoneal hernia. (*a*) Peritoneal reflection, pushed upwards. (*b*) The properitoneal iliac sac. (*c*) Neck of the femoral sac. (*d*) External prominence of the hernia.

In the female, the incision through Poupart's ligament presents no difficulty, as the contents of the inguinal canal constitute no obstacle and may be divided with indifference. Poupart's ligament and the different layers of the abdominal wall are divided directly upwards for a sufficient length, and the cut edges at once secured with forceps, which, in addition, serve as retractors; the parietal peritoneum is incised in its turn, the incision

being made continuous with the one already existing in the neck of the sac ; there will then be a free opening, through which any intra-abdominal manipulations can be carried out under direct inspection, and the various planes of the abdominal wall will afterwards be carefully reunited.

In the male, however, the presence of the spermatic cord necessitates special precautions. A certain amount of room can undoubtedly be obtained by incising Poupart's ligament up to the cord, and by retracting the margins of the opening strongly, but it is a very inadequate method.

It is better to adopt one or other of the following plans : (*a*) **To open the inguinal canal by an incision parallel to Poupart's ligament, to separate the cord, and to displace it upwards and inwards under a retractor,** and then to incise the deep inguinal wall vertically as in the female ; (*b*) **To approach the neck of the femoral hernia and the surrounding area by a supra-inguinal incision.**[1]

The aponeurosis of the external oblique is split along the anterior wall of the canal, just as in performing an inguinal herniotomy, but without interfering with the external inguinal ring ; the canal is opened up, the lower borders of the internal oblique and transversalis muscles are raised, the cord is separated and displaced (*Fig.* 161), then, in its turn, the posterior wall of the canal, the fascia transversalis, is incised or opened up with the director, and so the pre-peritoneal zone is exposed (*Fig.* 162).

Two routes are then available. It sometimes suffices to open up the extra-peritoneal fatty tissue and to separate the anterior parietal peritoneum from below upwards, to enable what is necessary to be done, as for instance to expose an intra-abdominal diverticulum of the hernial sac (*Fig.* 163). More often, however, it will be necessary to incise the peritoneum, and then there will be free access to the hernia from above.[2] Once the necessary objective has been achieved, the peritoneum will be carefully sutured and the different tissue-planes carefully restored.

STRANGULATED UMBILICAL HERNIA.

A strangulated umbilical hernia is an exceedingly grave condition, and although umbilical herniotomy has no longer its old-time sinister reputation, the mortality still remains relatively high. This bad prognosis

[1] This is the method of Ruggi and Tuffier (Tuffier, " Opération de la hernie crurale par voie inguinale," *Revue de Chirurgie*, 1894, p. 240.)

[2] " In cases of strangulated hernia, I have been astonished," writes Tuffier (*loc. cit.*), " at the facility and security with which the operation has been effected by the inguinal route. . . . The inguinal incision conducts the operator directly to the neck of the sac : a vertical incision then opens the peritoneum above the neck ; on retracting the edges of the wound, the herniated intestinal loop with its two parallel limbs, the surrounding omentum, the constricted portion, and the underlying structures, become visible. It suffices then to relax the constricting ring, either by direct incision of Poupart's ligament from above downwards, on the finger nail, or on any instrument suitable for protecting the intestine, or, following the old method, by means of the probe-pointed hernia knife cutting from within outwards. Personally, I first of all divide the omentum as high up as possible and get rid of it, and then I try to disengage the loop of intestine by gentle traction on the lower end ; in case of failure I incise the femoral canal or the neck of the sac directly."

must not, however, be imputed to the operation itself, but to the delay after which it is too often undertaken.

As a matter of fact, apart from the *true, acute, tight strangulations*, which at once make themselves obvious by characteristic symptoms and leave no pretext for procrastination, it is in the large hernias of the umbilical region that those subacute, insidious phenomena, paralytic or inflammatory, which have been designated by the names of *pseudo-strangulation, hernial obstruction*, or *hernial inflammation*, are most often seen ; these conditions have too long been considered particularly well adapted for treatment by expectant methods in some form or other.

The hernia is of old standing and, for a long time, only reducible with difficulty ; it has become painful, there is constipation and bilious vomiting, but obstruction is not complete and some flatus is still passed ; on palpation the hernial swelling does not give that sensation of general distention which characterizes typical strangulation, and it still retains some semblance of being partially reducible ; an obstructed hernia is diagnosed, and after a trial of taxis, almost always useless and often harmful, an ice-bag is applied to the abdomen, opium is given, and developments are awaited.

And in the great majority of cases, stercoræmic intoxication progresses slowly, without striking symptoms, but doing its work in sure and deadly fashion ; from day to day the face becomes more haggard, the pulse faster and feebler, and the abdomen more distended ; the vomit becomes brown and foul ; at last it is decided to operate, to perform the difficult operation which an umbilical herniotomy in these old, adherent hernias often involves, *on a patient in a condition of septic poisoning, whose vital resistance is hopelessly compromised.*

In some cases the outlook at first appears to be quite promising, the local symptoms do not become worse, and the general condition remains or appears to remain good, until, on the fourth, fifth, or sixth day, sometimes even later still, signs of strangulation appear and suddenly become complete, and the stercoræmia, after the long period of slow poisoning, at once assumes most threatening characters. Then it becomes absolutely necessary at last to perform the necessary operation, but under almost hopeless conditions. In such cases, the hour always comes when the danger must be faced, and *the longer the delay the greater the danger.*

To sum up, **early operation is quite as urgent[1] in these insidious cases of umbilical pseudo-strangulation as in true strangulation.**

The operation may be difficult and complicated, in the large hernias, it is true, but that is an additional reason for operating early ; an early

[1] I may here recall a sad case which I have already published elsewhere : a fine young woman, some thirty years of age, the mother of a family, was brought into hospital in a dying condition : for six days she had been suffering with a strangulated umbilical hernia ; someone, consulted at the beginning of the illness, had tried taxis, declared that reduction had been effected, applied a bandage, and withdrew. The symptoms, however, continued and became worse. There was another application of taxis, which again, so it appeared, was successful, and this time, the better to prevent the escape of the viscera, by way of compression . . . a stone was applied to the abdomen. Finally, the patient was brought to hospital : the pulse was uncountable, respiration jerky, and the end seemed close at hand. However, I decided to

operation alone can save the patient. A late operation, to which the surgeon will finally be reduced, can only serve to hasten the end.

I write with deep conviction, founded on too many cases to leave me room to change my opinion. I have seen the expectant method and repeated taxis put in practice; I have many times, in hospital surgery, been compelled to operate *in extremis* on poor women, in the last stage of stercoræmia, handed over in despair to the surgeon after all means of "wasting time" had been exhausted. Often the operation was simple, easy, and rapid; it would have succeeded without the slightest hitch if performed within the first twenty-four or thirty-six hours, but under the lamentable conditions in which I was forced to attempt it, it became fatal and "finished" the patient. On the other hand, I have operated on enormous, adherent, gangrenous hernias in aged women, and my patients have recovered, and whenever I have been able to choose my own time for operating, that is to say, when I have been able to operate in the initial stages, I have had excellent results. **Once more, it is not the operation which is to be feared, but rather the delay in operating.**

As we shall see shortly, the causation of the untoward symptoms is by no means the same in all cases of strangulated umbilical hernia. Constriction at the ring is found only in a certain number of the cases, and very often it is *in the sac itself* that the obstacle must be looked for. The omentum, which frequently occupies the umbilical sacs in enormous masses, adhering to their inner surfaces and dividing the cavity into compartments, bridles and kinks the intestine, fixing it and placing it in the condition most suitable for the occurrence of paralytic ileus, and sometimes, without at any one point producing total obstruction, so multiplies the hindrances to the intestinal circulation as to cause its complete arrest.

After all, what can taxis effect in these adherent hernias? The umbilical ring is often free, and permits a partial but deceptive reduction; the difficulty is not at the ring, it is in the sac, and by open operation alone can it be recognized and overcome.

THE TECHNIQUE OF UMBILICAL HERNIOTOMY.

It is therefore necessary to operate early, particularly in the large hernias, and to do the operation properly we proceed thus:—

Careful general anæsthesia[1] if necessary, or better, local cocaine anæsthesia; envelopment of the limbs in wool; washing and disinfection

give the patient what chance there might be by immediate operation. A little chloroform was cautiously administered, and I opened the sac; it contained a little omentum and a loop of small intestine, only slightly adherent, and still quite sound in its entire length; the ring was not tight; the incision, reduction, excision of the sac, and suture of the ring, required scarcely more than ten minutes. But it was too late; the patient died. ("La hernie ombilicale étranglée," *Presse Médicale*, 1896, pp. 81 and 117.)

[1] Extremely dangerous, however, with a patient in a state of stercoræmia; the anæsthetic ought, therefore, to be given in as small a quantity and for as short a time as possible.

of the entire surface of the abdomen—we need not dwell on these routine preliminaries.

The hernial swelling is of somewhat variable form, hemispherical, often nodular, sometimes looking very inflamed; it displaces the umbilicus upwards or downwards, sometimes laterally; *in the umbilical hernias*, strictly so-called, which come forward through the umbilical ring, the deep umbilical depression is usually turned upwards; it looks downwards and is hidden by the lower slope of the rounded swelling *in the para-umbilical hernias* which are so often seen.

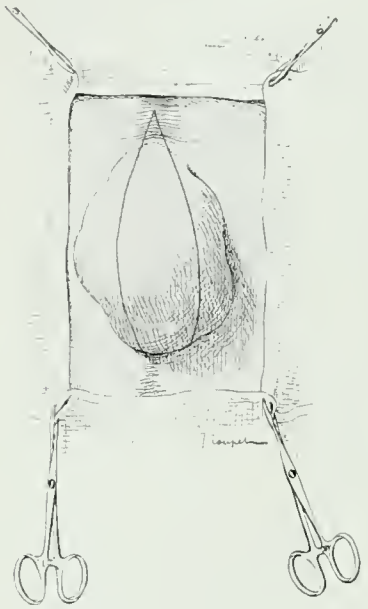


Fig. 164.—Umbilical herniotomy. Double semilunar incision.

However, these different forms need only be mentioned; whether umbilical or para-umbilical, whether it comes through the linea alba above or below the umbilicus, the characters and evolution of the hernia are identical. We need merely remark that the deep and distorted umbilical depression requires special attention in the cleansing of the skin; it should be everted by catching hold of and pulling up the bottom of the cul-de-sac with Kocher forceps, so that all the recesses may be adequately disinfected.

Make a **vertical median skin incision** which crosses the hernial swelling in its chief axis; let the two extremities of the incision extend well beyond, above, and below the margins of the prominence; **much time will be saved by providing abundant room.**

Over the centre of the hernia, at and around the umbilicus, the skin is very thin and very adherent to the hernial sac, and with the latter often forms a common wall, almost transparent and parchment-like. Use the edge of the knife lightly in this situation; to open the sac with the first cut is scarcely an accident, it is sometimes almost a simplification; still, lying in contact with the deep surface of the sac or of the thin cutaneo-saccular wall, there may be a distended loop of intestine, and in such circumstances the intestine has often been wounded or opened.

Therefore, if the skin and the sac appear to be at all thin or intimately adherent at the central part of the hernia, begin the dissection some distance away, above or below, at a point where fat intervenes, and continue it from the easily separable periphery towards the more adherent central part.

There is another and still better method; if the hernia is large and the skin thin, congested, and altered, instead of the median incision, **make two semilunar cuts circumscribing an oval area of skin** (*Fig.* 164)

which will be excised along with the sac; the two curved incisions will at once open up the fatty-cellular tissue where the association between sac and skin is less close.

1st step.—**Isolation and Opening of the Sac. Examination of the Contents.**—Here again, the first step ought to consist, as far as possible, in separating the unopened sac from its surroundings, in enucleating it "like a tumour." If it is very large and nodular, with all the distended bosses adherent to the skin, this enucleation would be too long and troublesome, seeing that it is only a preliminary to the principal, intra-saccular part of the operation. But, such exceptional cases apart, this *preliminary enucleation en masse* of a hernial sac, often very irregular, segmented, and with numerous diverticula, is always of the greatest advantage, and once it is properly completed, the whole mass will lie freely exposed to view.

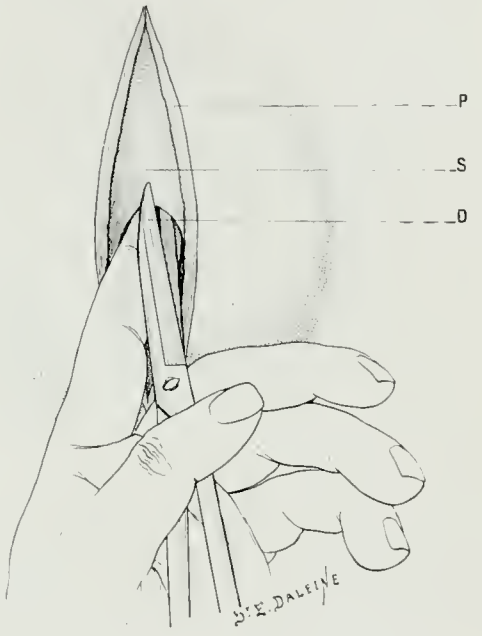


Fig. 165.—Umbilical herniotomy. Incision of the sac. (P) Skin. (S) Sac wall. (D) Scissors dividing the sac wall on the finger.

Then **open the sac in the middle line,** picking up a fold, as usual, of the thin and transparent wall at some non-adherent spot; enlarge the opening, slip in the finger, and on it extend the incision with the scissors, from below upwards and from above downwards (*Fig.* 165). This incision will not always be quite straight and exactly median; in places a thickening or an adherent zone will be encountered which it will be necessary to separate or to go round.

If a double curved incision has been made, circumscribing an oval area of skin, it will be well to open the sac also along the lines of the semi-lunar incisions, and then, after separating the adhesions to its deep surface with the finger, the median segment will be excised, and free access will be provided to the interior of the sac.

I need hardly say that the two edges will be at once secured with forceps.

The sac contents are exposed; as we shall see later on, they are by no means always of the same nature, but I presume that we find the most

usual condition: *a thick layer of adherent omentum, covering a long loop of intestine.*

The intestine will be invisible at first; only the omentum can be seen, and the first care must be to detach and raise the omental covering; then only will it be possible to recognize exactly the contents of the hernia.

It is well to carry out the separation with strict method; working hastily and by chance it is very easy to "lose oneself" amidst the matted contents of a large umbilical hernia. Take one of the edges of the sac, make it taut with the forceps which have been placed on it, and begin the separation from before backwards with the finger, keeping close to the inner surface of the sac (*Fig.* 166); in some rather more adherent areas it may be necessary to use the grooved director or the end of closed, curved, blunt scissors; apply forceps to and cut any bands which will not yield, and also secure with forceps those which break. Then pass to the lower part of the sac, and if any portion of omentum is too adherent, do not waste time in trying to separate it, but catch it between the jaws of pressure-forceps and cut between these and the sac.

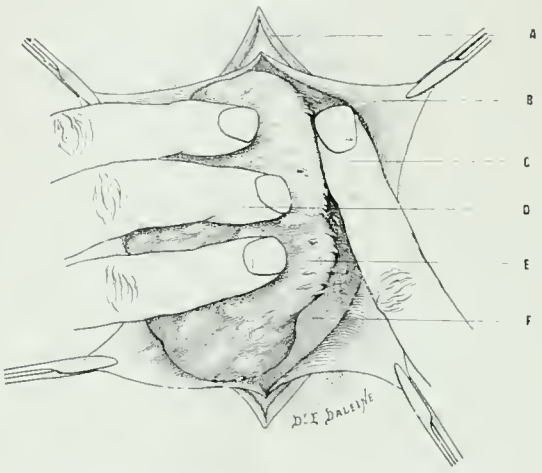


Fig. 166.—Umbilical herniotomy. Separating the omentum. (A) Skin. (B) The opened sac. (C) Index finger separating the omentum from the inner surface of the sac. (D) The fingers of the left hand drawing the layer of omentum aside. (E) The omentum. (F) The herniated loop of intestine, lying behind the omentum.

The surgeon will then be able to raise the whole mass of omentum, breaking down, strand by strand, any minor adhesions which still remain; in the multilocular sacs, he will find omentum adhering in large masses in each of the pockets; these prolongations must be enucleated, and in doing so, it will be necessary to split the fibrous ring which surrounds the entrance to each diverticulum.

The omental curtain is turned back and the intestine comes into view, a blackish, distended loop, naturally of very variable length and appearance.

Before going further, irrigate the visible contents of the sac with boiled salt solution, then carefully wipe the omentum and intestine with an aseptic compress, and examine the wall of the intestine to make sure that there is no lesion ready to perforate and demanding special precautions in order to prevent a sudden escape of intestinal contents into the abdomen during the subsequent manœuvres.

2nd step.—**Relief of Constriction.**—It happens sometimes that the constriction is so slack that a moderate degree of traction suffices to draw down the constricted portion of the bowel and the coils immediately above; this is particularly the case in *the intra-saccular strangulations* of which we have spoken above. An incision may then perhaps be almost superfluous; still it is always well to provide a free way, so as to avoid the need for any force in the reposition of the hernial contents, and, further, a preliminary incision really facilitates the closure of the ring.

Make an incision, therefore, where most convenient, upwards and to the right for instance (*Fig.* 167), but preferably **in the middle line**; there is absolutely nothing to fear if the following simple method is employed.

Turn down the omentum, and free the upper margin of the ring carefully; this can always be quite definitely seen and felt, and once more we would add that it is absolutely necessary to see what is being cut. Slip a finger under the ring, and on that finger divide the aponeurotic abdominal wall with the scissors (*Plate VI*); an incision half an inch or so in length is sometimes sufficient, and it may be prolonged if necessary.

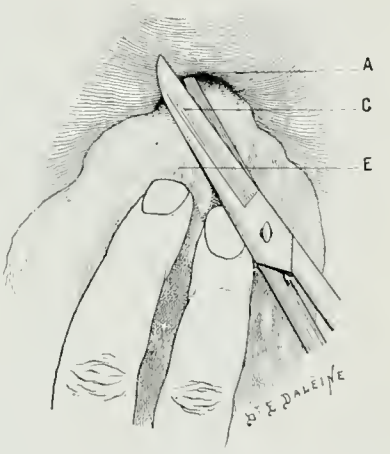


Fig. 167.—Umbilical herniotomy. Incising the neck, upwards and to the right. (A) The arching upper margin of the ring. (C) The scissors dividing the ring, upwards and to the right. (E) The contents of the hernia drawn downwards.

Then at once get rid of the omentum; complete the separation of the adhesions at the neck of the sac, draw down the pedicle, tie it with inter-locking ligatures (see SIMPLE STRANGULATED INGUINAL HERNIA), and cut it; cleanse the stump carefully and reduce it.

If the mass of omentum is very large, and the application of the ligatures is likely to occupy some time, it is often better to deal with the intestine first; in that case put a clamp on the omental pedicle and excise all the mass which encumbers the field of operation, placing a compress over the clamped stump, which will afterwards be ligated and reduced.

In dealing with **very large umbilical hernias**, the operation can be better and more rapidly performed by proceeding as follows (*Plate VI*).

The cutaneous incision is made circularly around the periphery of the hernial swelling at a sufficient distance from the base of attachment, to allow of the edges afterwards being brought together without tension; the sac is then opened carefully along the line of the external incision, the omentum being separated bit by bit as the incision is carried round the sac.

The outer margin of the incised sac is at once secured with forceps,

freed from adhesions, and turned back; the central portion of the sac remains adherent to the skin and the omentum; this triple covering will presently be removed *en masse*.

Before doing so, however, turn to the pedicle of the hernia, pass a finger under the upper margin of the ring, raise it up and divide it freely. The root of the protruding omentum is then exposed; draw it down, free it all round, and after having secured it with forceps, or ligated it in small segments, cut it below the forceps or ligatures.

Then grasp the lower edge of the cut omentum, the sac, and the skin (*Plate VI*), with forceps or with the fingers of the left hand, and by turning the whole mass inside out from above downwards, breaking or cutting the restraining bands, gradually liberate the intestine.

3rd step.—**Reduction.** The intestine, in its turn, is drawn down into the sac, and we presume that it is not seriously affected and that no gangrenous plaques are present. It is carefully examined in its whole extent, and especially at the site of constriction, and under the influence of warm boiled water its wall assumes a brighter colour and recovers some tonicity and signs of life.

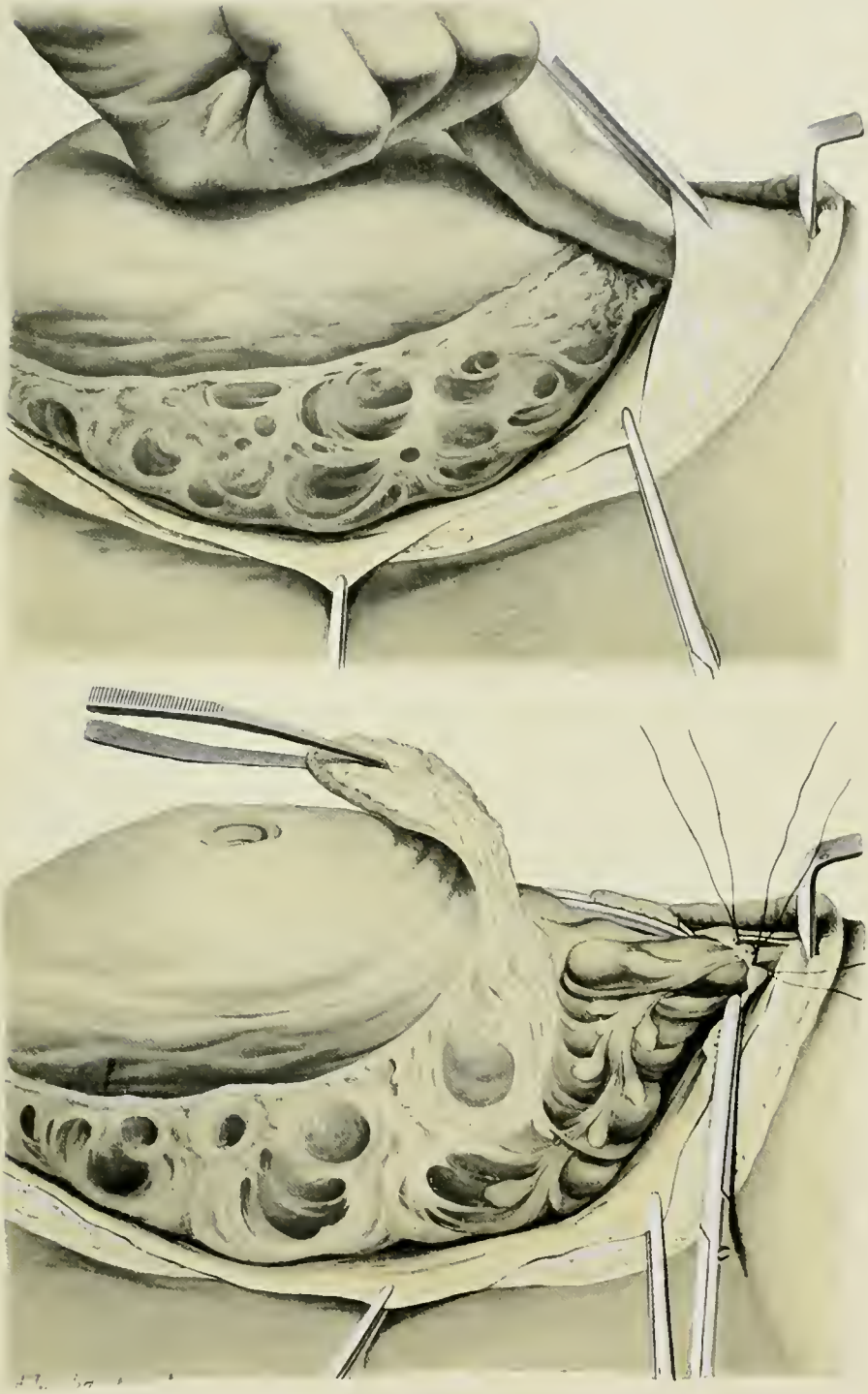
Reduce it then, having first of course repaired any lacerations of the sero-muscular coat or mesentery which may be present.

Reduction is by no means always easy; when there is only a single loop of small intestine of moderate length, the desired end can be obtained without trouble, by first expressing the contents, and then steadily pushing back one of the ends while the other is maintained in the vicinity of the ring. *But the intestinal mass is sometimes very large*, including perhaps, with enormous coils of small bowel, a portion of the large intestine, the entire transverse colon, or indeed all the abdominal viscera. Add to this the retraction of the abdominal wall in old-standing cases and the straining of a patient who is breathing badly, and it is easy to foresee the difficulties which may be encountered in open reduction.

However, no good can be done in such a case by force; it is useless to try to push back the large bundle of intestines in a mass; if methodical attempts are unavailing, if fresh loops emerge as others are reduced, **enlarge the incision** in the middle line, **secure the two edges with forceps, and raise them up, spread a large compress over the surface of the intestines to be reduced,** tucking its margins in under the abdominal wall all round, and **then press back gently with the outspread hands,** beginning at the periphery, in the manner which we have described elsewhere in relation to laparotomy for intestinal obstruction (*Vol.* i, *p.* 462).

One can always succeed in effecting reduction by this method of using a compress, combined with a free incision, if the omentum has first of all been completely separated.

Plate VI.—Umbilical Herniotomy. Very large hernia. *Upper figure*: the semilunar incision has been made, the sac opened laterally, and its external lip secured with forceps; incision of the ring on the index finger. *Lower figure*: the ring has been incised; the omental pedicle is ligated in small segments and cut, and the two ends are clamped; the omental covering, thus detached at its root, is turned down, its deep surface separated, and the intestine exposed.



UMBILICAL HERNIOTOMY

4th step.—**Restoration of the Umbilical Wall.**—Everything having been reduced, make sure that there is no bleeding, that no band still remains adherent in the neighbourhood of the deep surface of the ring, and next proceed with the restoration of the umbilical wall by **excision and closure of the sac, and suture of the wall.**

If the operation has commenced by isolating the sac like a tumour, it will as a rule be a very simple matter to bring the two portions together, to draw down the neck, to free it well all around, to apply a double interlocked ligature and to cut it away beyond this. If the wall is to be restored satisfactorily, *the stump of the sac must not be allowed to remain at the centre of the ring like a plug, but must be able to retract freely.* When the sac, on account of its great size or irregularity, has not been enucleated at the first, separate it rapidly, by free dissection encroaching on the surrounding fat.

In cases where it has been necessary to make an extensive incision in the neck of the sac, or if the linea alba has been freely split for the reduction of a large mass of intestine, it becomes very difficult or impossible to make a pedicle at the neck of the sac and to ligate it; **the two peritoneal edges must then be united by a continuous suture** as after a laparotomy; and when they are adherent, thin, friable, and tear under the slightest tension of the thread, it is necessary to include the peritoneum and the deep layers of the abdominal wall in the same continuous suture; or again, the two edges of the wound may be brought together, in their whole thickness, by a series of interrupted U-sutures, described later.

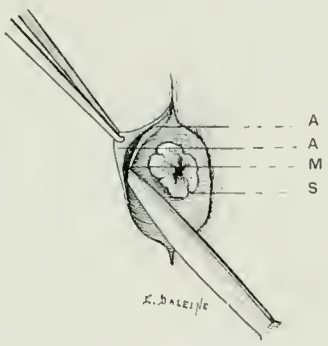


Fig. 168.—Umbilical herniotomy. Repairing the wall. Opening the sheath of the rectus. (A) Deep layer of the sheath. (A′) Superficial layer of the sheath. (M) Rectus muscle. (S) Stump of the sac.

As a matter of fact, the suturing of the wall after a herniotomy performed for strangulation can only rarely be performed with the minute attention to technical detail which is applied to a radical cure undertaken as an operation of election. After a difficult and troublesome operation, it is necessary to work quickly, and to complete the repair of the wall in as short a time as possible. One or other of the following methods may therefore be adopted, according to the local conditions and the time available.

(*A*). The umbilical orifice is enlarged, upwards and downwards, for about an inch; then on either side the sheath of the rectus muscle is opened by a vertical incision (*Fig.* 168). After a little dissection there will be three different planes to be united separately: *the posterior layers of the sheaths, the inner borders of the two rectus muscles, the anterior layers of the sheaths.*

Bring these three layers together by a triple continuous suture (*Fig.* 169); it is usually the posterior layer which is least well adapted for

satisfactory suturing; when the abdomen is large and the wall retracted, it tears and the stitches cut out.

The assistant should apply his two hands flat to the sloping surface of the abdominal wall on either side, and press the two edges of the wound together, and the stitches should include a good thickness of muscular tissue along with the posterior layer. Some interrupted sutures, carefully placed, —that is to say, at points where the fibrous layer is thickest and at the fibrous intersections in the muscles—are often preferable to a continuous suture.

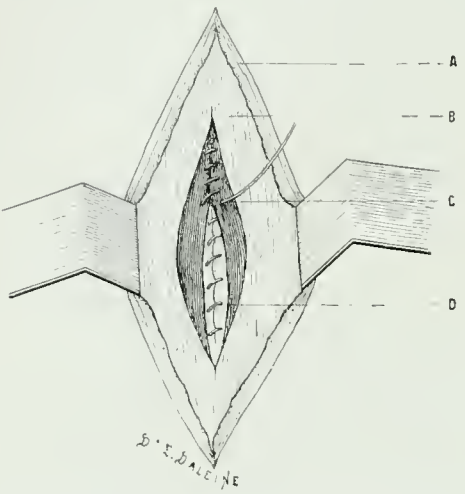


Fig. 169.—Umbilical herniotomy. Restoration of the wall in three layers. (A) Skin. (B) Superficial aponeurosis. (C) Suture of the inner borders of the recti muscles. (D) Suture of the deep aponeurosis and the peritoneum.

This **method of suturing in three layers** is the best means of securing a satisfactory closure of the opening if conditions of time and the tissues permit.

(*B*). In order to effect reduction, it has been necessary to make a very extensive incision; the two edges are retracted and can only be approximated with difficulty, and time presses. In this case *pull up the edges of the wound with forceps* which have been placed on them, while the hands of the assistant keep the intestines back under a compress; then, using a long Reverdin needle, introduce a sufficient number of **transverse U-sutures, each including the whole thickness of the muscular and fascial planes of the abdominal wall**; when these sutures are tied, they will bring the two sides of the wound together, peritoneal surface to peritoneal surface, and with the edges of the different layers directed forwards like a keel.

These transverse loops, including the whole thickness of the wall, offer a very decided resistance to the tension on the wound, and if carefully introduced will give very good permanent results. The protecting compress is withdrawn before the last suture is tied, and finally the two edges of the wound which are projecting forwards are adjusted by means of a complementary continuous suture.

I have employed this method of *reunion by lateral application of the lips of the wound*, not only at the end of operations for strangulated hernia, but also for the cure of large ventral hernias, and have found it very useful.

(*C*). Lastly, in cases of extreme urgency the operator will sometimes be compelled to limit himself **to simply uniting the margins of the ring** by

some interrupted sutures, after having freshened their inner surfaces a little. In similar conditions, if the orifice is of moderate dimensions and is filled by the stump of the sac, one may even dispense with sutures and trust to the stump to act as a plug. Whichever method of repairing the wall is adopted, it must be carried out quickly; the masses of fat which encumber the wound, and also the thin redundant portions of skin, should be rapidly excised, and the edges of the cutaneous incision, which are sometimes very thick, sutured together. It need not be said that a broad flannel binder, well padded with wool and firmly applied, represents the indispensable complement of the dressing.

It must be recognized that though umbilical herniotomy is sometimes, in the large adherent hernias, a very difficult operation, it is in reality, in a great number of cases, a comparatively simple procedure, if methodically performed. One should always endeavour to effect reduction, even when dealing with a hernia of enormous size, everywhere adherent, and necessitating a most troublesome separation.

If the undertaking is too difficult, and the state of the patient too alarming to permit of any prolongation of the operation, there remains a last resource: to incise the ring freely, separate the intestine from the layer of adherent omentum which covers it, and resect the omentum if possible, **to break down the intra-saccular bands and to leave the mass of intestines thus liberated in the sac**, which is closed forthwith. Later on, when the acute symptoms have subsided, renewed attempts at open reduction will be made.

This method is a makeshift, but it may be useful in some very large hernias, and when there is intra-saccular strangulation.

In the following pages we shall consider the line of treatment to be adopted in dealing with the various forms of gangrenous hernia.

GANGRENOUS HERNIA.

Up till now we have supposed that the herniated intestine was in a sufficiently healthy condition to admit of no doubt as to its fitness for reduction. This is by no means always the case; the intestinal loop just exposed in the sac sometimes presents certain objective characters of surface, of colour, and general condition, which awaken serious suspicions as to its ultimate fate; in short, it is suspect, and to reduce it as it is would be to incur a serious risk of secondary peritonitis from perforation.

At other times, the intestine *is definitely gangrenous*, though it still *preserves its continuity* and its wall is physically intact.

In other cases again, the gangrene expresses itself by *one or more perforations*, by a loss of substance of varying extent, through which intestinal contents have escaped and caused a fæcal abscess.

In the presence of such varied possibilities it is often very difficult to decide on the correct line of treatment, and to make the best of these.

always very grave, situations, it is absolutely necessary to base one's action, not on theoretical indications nor on the results of statistics—which are always found wanting in some way or other—but on practical points as precisely defined as possible.

I.—SUSPECTED INTESTINE.

We have already said that the vitality of the strangulated loop must not be judged only by the appearance it presents when the sac is opened, but by that which it assumes *after some minutes have elapsed after the strangulation has been relieved, and under the influence of warm boiled water.*

If it remains in places of a dirty, lustreless, greyish-black, or of a brownish-russet tint, or again, with yellowish streaks or spots on a purple base; if the serous surface has lost its gloss, if it is covered at some points with pseudo-membranous patches of a greyish-yellow colour; and if it presents at these points, and more particularly at the site of constriction, areas of thinning or of deep erosion—all these are so many indications that its vitality has been gravely compromised, and though the circulation may still be re-established and the ulcerative processes checked, the chances are too uncertain to allow one to take the responsibility of reduction pure and simple.

What is to be done then? **Relieve the strangulation, without reduction,** which practically amounts to the following.

Carefully cleanse the cavity of the sac and the whole surface of the suspected loop; tie and resect the omentum; *incise the constriction sufficiently to allow the ends of the intestinal loop to be drawn down quite freely* for a length of an inch or so, and make sure by gentle pressure that *the channel is duly re-established* and that the intestinal contents can circulate easily.

Then envelope the loop with aseptic compresses which cover and protect it completely, without compressing it, and fill the gaping cavity of the sac; introduce one or two sutures only at the extremities of the wound, and enclose the whole region in a large dressing.

If the loop is long, it has usually no tendency to slip back spontaneously into the abdomen, at least during the first few days, and it suffices to arrange the compresses properly around the pedicle to prevent any chance of such an occurrence.

On the other hand, if the loop is short, it will be well to secure it at the neck or to the bottom of the sac by a few catgut sutures; a better plan will be to pass a piece of a boiled elastic catheter through the mesentery and to leave the suspected loop riding on this rod, which again rests on the edges of the wound, exactly as is done with the sigmoid colon in the first step of a colostomy (*Fig.* 170). The intestinal area which appears to be in the most doubtful condition may also be sutured to the walls or to the bottom of the sac, in such a manner as to circumscribe in advance the field of a probable perforation.

The intestine will be kept under observation for a certain number of days, the time varying according to subsequent developments. If the symptoms of strangulation disappear, if one or more proper motions are passed, if the loop "in quarantine" becomes warm, red, and of uniform calibre, one will wait for four or five days, disturbing the enveloping compresses as little as possible, and at the end of that time, without replacing it at once in the abdomen, "it will be allowed to re-enter."

In fact, accordingly as its functional activity is restored and the sac-wound narrows, the intestine retracts and gradually reduces itself; it will be sufficient to remove the fixation sutures or the piece of catheter (*Fig.* 170) if need be, and to remove the gauze packing from the vicinity of the opening, to enable this spontaneous reduction to take place; of course, if the bowel is unduly slow in returning to the abdominal cavity, it may be reduced directly.

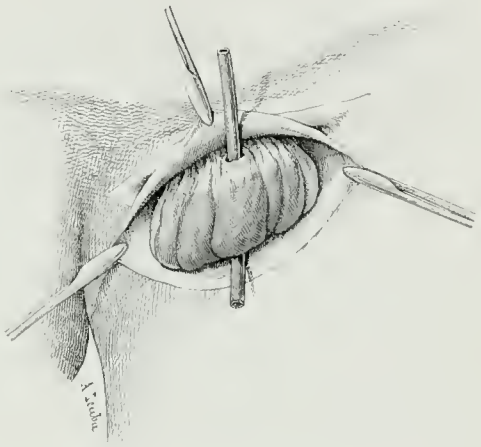


Fig. 170. Relief of constriction without reduction. The suspected loop retained outside.

In other cases the gangrene advances and perforation occurs, but by that time the abdominal cavity will be shut off, and the condition is simply one of an artificial anus or a fæcal fistula, which can subsequently be dealt with as may be necessary.

Lastly, this method—which, however, is but rarely applicable—lends itself to different modifications, as variable as the hernial lesions themselves.

It may be that the condition of the intestine is really suspicious only at a limited area, at the site of a circumscribed plaque, for instance, or at the neck; the method of invagination which we shall describe immediately may then be used with advantage. The doubtful area of the intestinal wall is depressed, folded inwards towards the lumen of the bowel, and buried by suturing the adjacent healthy intestinal wall over it by means of a double Lembert suture (*Fig.* 171). Reduction will then be legitimate if there are no other contra-indications.[1]

[1] We shall merely mention the plan followed by Helferich ("Ueber die Ausführung der Herniotomie bei der Gangrän verdächtigen Darm." *Arch. f. klin. Chir.*, 1891, Bd. xli., p. 337) in two cases: a very reasonable and interesting plan, but too complicated to be recommended in urgent surgery, except in very unusual circumstances.

In these two cases, Helferich, finding a strangulated, suspicious loop, left it outside, after having put the two ends in communication by an entero-anastomosis made in a healthy portion. The result of this anastomosis is to ensure forthwith a free passage for the intestinal contents, and to place the affected loop more completely at rest; further, if gangrene and perforation should occur, the conditions would be such as to favour the rapid closure of the resulting fæcal

II. GANGRENOUS BUT NOT PERFORATED INTESTINE.

The gangrene is indicated by the greenish or bronzed, dead-leaf colour, by the dull, lustreless appearance of the surface and the coldness of the wall, often by a quite special, fœtid, putrid odour of the affected loop of intestine, and finally by the absence of any sign of recovery, of any change in appearance, after the constriction has been relieved and after lavage with warm, boiled salt solution. The gangrene is of variable distribution and extent in different cases.

1. **Gangrene in an Isolated, Circumscribed Patch.**—Sometimes there are *several discrete patches of gangrene* of limited extent, or perhaps only *a single patch* at the position of the neck, in the zone of maximum constriction; the rest of the loop presents an appearance and characters indicative of sufficient vitality.

In such conditions the correct treatment is to repair the local lesion and then to reduce the intestine, or if necessary to treat it as suspected (*see above*). The local repair may be carried out in one of two ways: **by invagination of the gangrenous patch, or by excision of the patch, followed by lateral enterorrhaphy**; for either method it is essential that the gangrene shall not have extended beyond half the circumference of the intestine; both have two dangers to be avoided, *stenosis* and *kinking*.

(*A*). **Partial invagination**[1] may be practised in the longitudinal or transverse direction, according to the position of the chief axis of the gangrenous patch; two folds of the adjoining intestinal wall are brought over it and sutured together, as shown in *Fig.* 171.

To do this the continuous sero-muscular suture must always be begun a little distance beyond the patch to be covered in, and must end at a corresponding distance beyond the further border, to insure the complete burying of the affected area; if necessary, a second continuous suture or some interrupted sutures may be used to secure more perfect coaptation of the two lateral ridges of the intestinal wall.

It is quite evident that if the dimensions of the area to be invaginated exceed certain limits, the lumen of the intestine may be unduly narrowed if the suture line lies in the long axis, or the intestine may be acutely kinked if the suturing is done transversely; further, the safety of the method is entirely dependent on firm union between the two sero-muscular folds, and therefore on broad apposition of their serous surfaces. When thus

fistula. The operation has only one fault, namely, its duration; in one of Helferich's cases it took an hour and a half; in the other, an hour and a quarter; during the course of an operation for strangulated hernia this time factor is of great importance; and, further, the conditions in which these hernial operations are often performed do not always lend themselves to the correct execution of an intestinal anastomosis. One of Helferich's patients recovered, the other died; and, as Helferich himself says, it is not improbable that the duration of the operation had something to do with the fatal termination.

[1] Martinet, of Sainte-Foy-la-Grande. Rapport de Chaput. *Bull. de la soc. dechir.*, 1894, p. 246.

buried, the gangrenous patch is ultimately eliminated into the intestinal cavity.

The invagination may be repeated on two or three areas of gangrene if their relative positions and extent permit, and we shall see presently that when there is gangrene *en masse* of a whole loop, **total invagination** into the lower end, as recommended by Guinard,[1] can, in certain definite conditions, give very good results.

(*B*). **Excision.**—If the gangrenous patch is thick and rigid, if it can only be invaginated with difficulty, if the lateral folds cannot be readily raised and brought in contact, and can only be sutured with difficulty because of the friability of the intestinal wall, if the patch is too extensive or too irregular to be readily buried, or again if it appears to be on the point of rupturing: **excision,** and particularly **a lozenge-shaped excision followed by appropriate suture,** is the most suitable method.

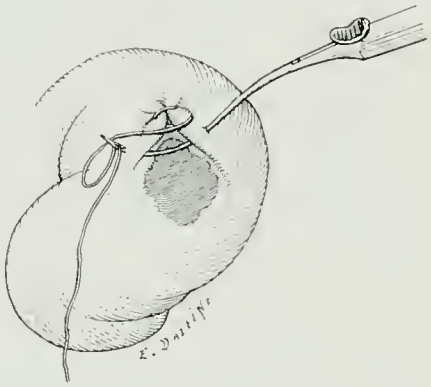


Fig. 171.—Invagination of a circumscribed patch of gangrene. The gangrenous area is buried by bringing two lateral folds of the sero-muscular wall over it with a continuous suture.

Of course it necessitates the opening of the intestine, but with some care in arranging compresses around the area, it will be possible to operate practically in a closed space, and indeed, when performed with a well-ordered technique, lateral enterorrhaphy is a comparatively simple and usually successful procedure. Displace the intestinal contents on either side with the fingers, and adopt some one or other of the usual means of occluding the intestine; the fingers of a good assistant are often sufficient; if intestinal clamps are used they must be applied to healthy portions of the gut at some distance from the affected segment, the strangulated loop being sometimes very susceptible to injury through compression, even beyond the gangrenous zone.

Then, with the dissecting forceps, raise up the patch which is to be excised, open it with a snip of the scissors and cut it away, *encroaching a little on the healthy and bleeding tissues*, and giving the gap the form most suitable for subsequent longitudinal or transverse union, whichever will least interfere with the permeability of the bowel. A lozenge-shaped incision is to be recommended in all cases where the deficiency resulting must be large; the suturing will be executed in the manner which we have already described. (See WOUNDS OF THE INTESTINE.)

[1] GUINARD, "Traitement des hernies gangrenées par l'invagination totale ou partielle." *Comptes rendus du Congrès de Chirurgie*, 1895, and Thèse de Gröll, 1895.

These partial, local repairs are very useful in certain cases, and permit of the affected loop being reduced into the abdomen after careful cleansing; still a loop of intestine which bears an actual patch of gangrene must always be considered as doubtful, and one will act wisely in going over it a second time, examining its surface closely, after having drawn down the pedicle sufficiently and covering up any suspicious greyish, eroded points with Lembert sutures. It is to be remembered that the ulcerative processes begin at the mucous surface and progress eccentrically; further, ulceration sometimes occurs above the strangulated segment, and may be the cause of late perforation.

2. **Gangrene in Large, Multiple, Disseminated Patches; Gangrene of the whole Loop.**— It is no longer one, two, or three isolated patches of gangrene of limited extent which are found, but a whole series of greenish or brownish spots, which cover the surface of the strangulated loop, and would evidently soon give origin to multiple perforations; or again, there may be complete gangrene of the whole loop, which is greyish-brown, greenish, or black, withered, and lustreless, but not yet perforated; in either case it is a question of **enterectomy followed by immediate union**, or of **an artificial anus.**

A place must, however, be reserved for the procedure to which we have already referred, when speaking of limited gangrene: **complete invagination of the gangrenous segment of intestine.** If the ring of dead intestine is short, and does not exceed a few inches in length, if it is flexible, and not too friable, if the mesentery is not too much infiltrated and thickened, if the intestine beyond the gangrenous area is not too much contracted, one may, following Guinard's example, attempt complete circular invagination. Guinard has in this manner succeeded in burying with complete success a gangrenous segment $3\frac{1}{2}$ inches in length.

It is into *the distal end* that the dead segment must be pushed, from above downwards, and the manœuvre must be carried out carefully and gently, to avoid producing a rupture or perforation, which if it occurred would at once destroy one of the chief advantages of the method.

Begin by detaching the mesentery from the whole of the segment which is to be invaginated; put forceps on any vessels which bleed; the mesentery, which will be dealt with when the invagination has been made, should in the meantime be placed under a gauze compress, unless it is itself gangrenous, when it should be at once excised in a wedge, the edges of which will afterwards be sutured together. Of course a sufficient length of intestine must be drawn outside the abdomen for all the manipulations to be executed easily.

Take the distal segment between the fingers of both hands, and holding it so, try by the pressure of the thumbs to infold the gangrenous segment, to make it enter into the distal one; this is the difficult step in the procedure. When a good fold has been raised at one side, carry it round the whole circumference of the bowel, following it with the border of the thumb, or if necessary using director or closed forceps.

When a complete collar has been made, the chief obstacle has been surmounted, and the further steps usually present little difficulty. Hold the distal segment between the fingers and thumb of one hand, and with the other steadily push in the gangrenous segment, always applying the fingers close above the invaginating collar and slipping them back according as the invagination advances: it is necessary to invaginate, not only the gangrenous segment, but also half an inch or more of the adjoining living wall, so that the suturing may be done on healthy tissues.

Once the invagination is complete, the next step is to secure it; a continuous circular suture through the sero-muscular coats, reinforced, if it seems desirable, by a second continuous suture or by a circle of interrupted sutures, will insure the permanent adhesion of the two intestinal walls and definitely isolate the gangrenous segment. Another continuous suture will approximate the edges of the gap in the mesentery, and it then only remains, after careful cleansing, gently to effect reduction.

This attractive method has certainly a place in urgent surgery, with the reservations that it should only be adopted when the gangrenous segment is of *moderate length* (4 inches as a maximum), and *that no time is spent in trying it when the rigidity of the two ends and the friability of the intermediate, gangrenous segment shows from the first that it is inapplicable.*

As a matter of fact, it is very rarely applicable, and in most gangrenous hernias, **intestinal resection, followed by end-to-end or lateral anastomosis, by suture or button, must be considered to be the best method**; that is not, however, equivalent to saying that it is always, or indeed very often, indicated. The age and the general state of the patient, the duration of the strangulation, and the evident degree of septic intoxication, are not the only points to be taken into consideration; it is for the operator to judge in view of the conditions whether he is able to carry out the work of resection quickly and well. Even in the best surroundings, with good assistance and ample equipment, resection is often a difficult undertaking in cases of large hernias, where it is necessary to excise a long segment of intestine, a large triangle of mesentery, and a mass of thickened, infiltrated, adherent omentum, itself gangrenous, and finally to perform enterorrhaphy; the operation often lasts much longer than had been expected, the dangers of peritoneal infection are multiplied, and the anæsthesia prolonged.

To sum up: the patient is young, or comparatively so, and has no serious constitutional disease; there are no threatening pulmonary symptoms, the initial stages of the operation have been short, the anæsthesia has been borne well, the pulse keeps good; the gangrene is extensive, but there is no perforation, not too many adhesions, and the conditions are fairly favourable for rapidly dealing with the intestine. Here we have everything that is needful; then go forward boldly, without useless discussion, without timid, incomplete attempts, which are more dangerous than any thorough method.

First draw a sufficient length of the intestine out from the abdomen, and pack it around with gauze.

For two inches at least beyond the extreme limits of the gangrenous area on either side, that is to say, in healthy, supple tissue, occlude the intestine temporarily, either by means of an assistant's fingers, or with two clamps sheathed with rubber tubing, or with a drainage tube or a strip of gauze passed through the mesentery and tied round the intestine.

For satisfactory suturing it is essential that the wall of the intestine should be neither infiltrated nor friable, and that the folds should allow themselves to be readily approximated; the length of the intestinal resection matters little; it is accurate and firm union that is all important.

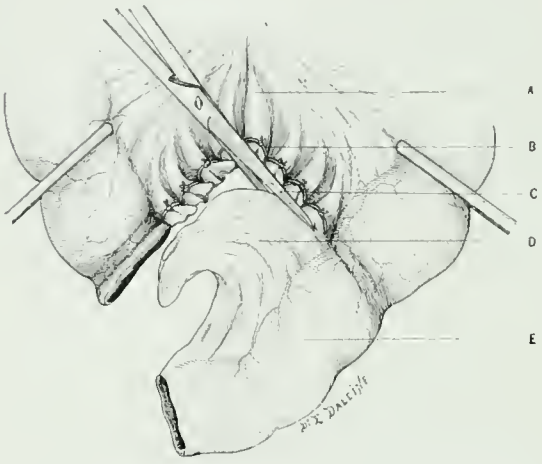


Fig. 172. — Intestinal resection. Section of the mesenteric triangle after the application of a double series of ligatures. (A) Mesentery. (B) Interlocking ligatures securing the mesentery in small segments. (C) Resecting the mesenteric triangle with the scissors. (D) The excised triangle. (E) The segment of intestine to be resected.

The intestinal contents have of course been displaced to either side before the clamps or ligatures were applied; still it is advisable to clamp each of the ends of the gangrenous segment, to obviate any leakage and possible contamination.

Together with the intestine, it is necessary to **excise a triangular portion of the mesentery**, the base of which will correspond exactly to the length of the resected loop, and must never extend beyond it; do not carry the apex of the triangle too far into the mesentery, or it may involve the larger vascular arcades. The mesenteric flap is cut with the scissors; the vessels are caught as they are divided, and tied afterwards.

But when the membrane is itself much infiltrated and friable, or when a very extensive excision becomes necessary because of the length of the gangrenous loop of intestine, direct section might involve the loss of a considerable amount of blood; in such circumstances it will be well *to circumscribe the two sides of the mesenteric triangle beforehand, by a double series of ligatures*, and so to insure hæmostasis and the avoidance of bleeding during the excision (*Fig.* 172).

The ligatures will be passed through the whole thickness of the mesentery, from one surface to the other, each ligature constricting only a comparatively small segment, and at the end of the operation the two borders will be brought together by a few interrupted sutures.

How is the continuity of the intestine to be restored? If the two ends are fairly large and of approximately equal calibre, **circular enterorrhaphy** will be practicable. We need merely recall the general technique of this method of intestinal anastomosis, which we have studied in detail elsewhere (see *Vol.* i, *p.* 322). The two ends are brought into continuity by a *first continuous suture including all the coats of the bowel*, taking care that the stitches are regularly spaced and introduced quite close to the cut edge, to avoid unduly constricting the calibre of the intestine. The suture begins at the mesenteric border, and is carried along the posterior cut edges till the anti-mesenteric border is reached; it then changes its direction and passes upwards along the anterior cut edges to reach its starting-point at the mesenteric border.

This first suture can be very rapidly introduced, and once the intestinal continuity has thus been mechanically restored, the sero-serous suture, on which physiological and permanent union depends, will be much more easily executed.

Turn the loop of intestine upwards, so that its posterior surface is directed forwards, and begin the *sero-serous suture* as close as possible to the mesenteric border, and carry it downwards, with closely set and regular stitches, to the inferior border (*Plate VII*); turn down the loop and continue the suture upwards over the anterior surface to the point where it started at the attached border. Here and there, and especially at the mesenteric attachment, if it seems necessary, add some complementary interrupted sutures.

When performed methodically, this circular suture can be executed much more quickly than might have been expected, even in one's first operations; there is no need of any special needle: a good ordinary sewing needle answers perfectly if used with a fine and strong thread. The important point is to know how to introduce the Lembert suture, the sero-serous suture which brings the opposing folds of the sero-muscular coats in contact.

Case 17.—One of the results which has impressed me most was in the case of an enormous strangulated umbilical hernia, in which I was compelled to resect 24 inches of intestine.[1] The patient was a very stout woman, whose abdominal wall was laden with fat; in the sac I found a large mass of adherent omentum, which had to be separated by cutting with the scissors into the sac wall and the surrounding fat, and a long loop of small intestine, with numerous patches of gangrene of a dirty-grey or dull-yellow colour; there had been no perforation, and there was no faecal matter in the sac, the contents of which, however, emitted a powerful gangrenous odour. The umbilical ring itself allowed the finger to pass without any difficulty. I rapidly completed the separation of the omentum, and especially the separation of the dense adhesions which fixed it to the circumference of the neck, and after having secured the

[1] The length of intestine to be resected is, however, a matter of secondary importance; according to Trzebicky, as much as ten feet of small intestine may be removed without seriously interfering with nutrition (Ueber die Grenzen der Zulässigkeit der Dünndarmresektion. *Arch. f. klin. Chir.*, 1893, Bd. xlviii., p. 54). After these extensive resections, the separated mesentery is the cause of considerable embarrassment; its triangular excision cannot be carried too high without considerable risk of causing gangrene through interference with the blood supply.

pedicle with an interlocking ligature, I excised the large mass. The umbilical ring having been incised, I drew out the healthy ends of the herniated loop of intestine; I then passed a double series of interlocking ligatures through the mesentery, circumscribing the triangular area to be excised along with the intestine. Hæmostasis having thus been assured, two twisted strips of gauze were tied round the healthy portion of bowel on either side of the gangrenous segment, and the intestine divided between them, the gangrenous portion being removed without the slightest leakage of its contents. I then proceeded to perform circular enterorrhaphy; the two ends of the intestine were brought together and united by two layers of sutures; some additional interrupted sutures placed along the line of junction gave further security by insuring the apposition of broad serous surfaces. The sutured loop was carefully sponged with boiled water and reduced. Apart from a small fæcal fistula, which only discharged for a few days, the patient made a simple and complete recovery.[1]

If there is a great disproportion in calibre between the two coils of intestine, the better practice will be to close the end of the larger segment and to implant the end of the narrow segment laterally, a little higher up, in the following manner[2]:—

The loop has been clamped and cut on either side and the intermediate segment removed; leave the lower, narrow end under a compress and deal with the upper end first; close it by bringing its walls together, first by a deep continuous suture including all the coats on either side, and then by a superficial, continuous, sero-muscular suture. It is well to make the latter very wide, seeing that there is no need to economize tissue; let it extend upwards on either side for a distance of a third of an inch or so, the better to insure complete closure (*Fig.* 173).

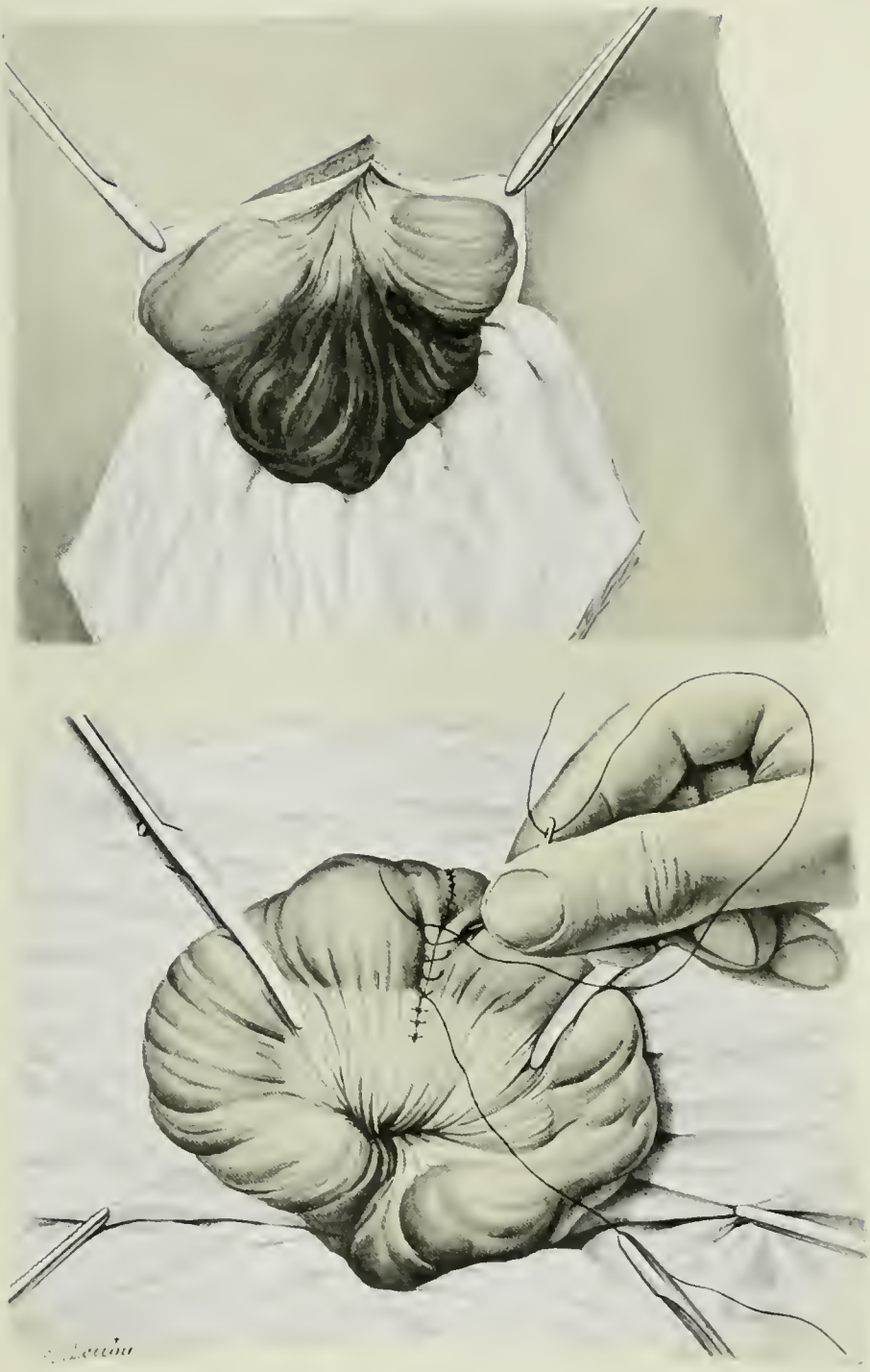
Then, about an inch higher up, incise the intestinal wall longitudinally on its anterior surface, and make an opening corresponding to the diameter of the lower end. Into this opening the lower end is to be implanted. Bring the two orifices together, the terminal opening in the small end and the lateral opening in the large one, and unite them by circular suture in two layers in the manner already described. First join the two posterior lips by a continuous sero-serous suture, then by an inner suture including all the coats, which, continued round the lower angle of the junction and along the anterior edges, completes the restoration of the continuity of the canal; then returning to the sero-serous suture which had been interrupted at the lower angle of the junction, it, in its turn, is continued along the anterior surface, and so the anastomosis is completed (*Fig.* 174).

With care and some practice, this termino-lateral anastomosis, with closure of the large end, takes no more time than the various artifices which have been devised for the purpose of enabling ends of unequal calibre being joined together directly, and the result is much more certain.

[1] *Société de chirurgie*, 6 déc., 1895.

[2] If the operator has had previous experience of it, and knows how to do it quickly, this termino-lateral enterorrhaphy ought to be regarded in all cases as the method of choice.

Plate VII.—Gangrenous Hernia. *Upper figure*: the constriction has been relieved and the segment of gangrenous small intestine is drawn out. *Lower figure*: circular enterorrhaphy after resection of the gangrenous segment; the continuous sero-serous suture.



GANGRENOUS HERNIA

Of course, after this lateral implantation, the two edges of the gap in the mesentery cross and overlap; this, however, will cause no inconvenience if the two flaps are maintained in apposition and the interval between them is obliterated by a few sutures.

Whatever the relative calibre of the two ends may be, absolutely the best plan consists in closing them both and anastomosing them laterally. Unfortunately, the technique of a **latero-lateral anastomosis** is rather difficult, and takes some time, and time is an element of primary importance in these operations for gangrenous hernia. For this reason, if a **Murphy's button** or one of its modifications is at hand, it may sometimes be used with decided advantage; it can be employed quite as well for a termino-lateral or latero-lateral anastomosis as for end-to-end union; it enables the operation to be completed more quickly, and ought always to form part of an emergency equipment.

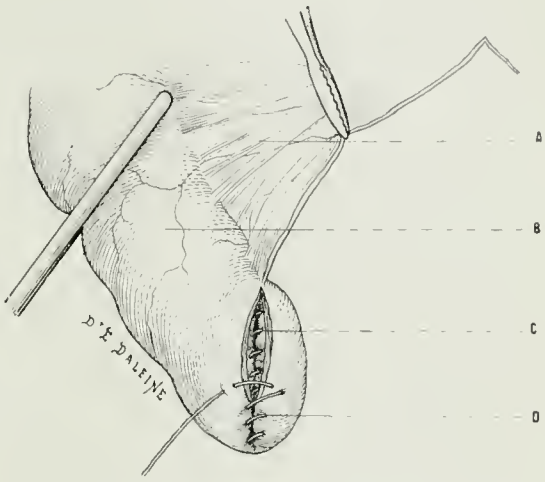


Fig. 173.—Enterorrhaphy by lateral implantation. 1st step Closure of the large end. (A) Mesentery. (B) Lower end of the intestine. (C) Muco-muscular continuous suture. (D) Sero-muscular continuous suture.

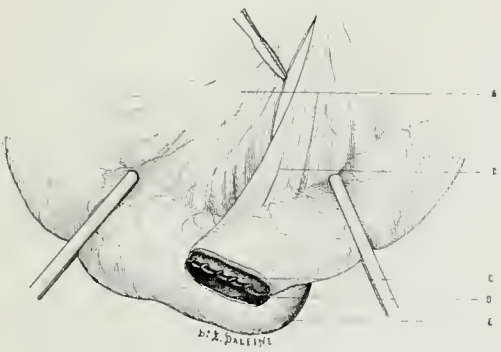


Fig. 174.—Enterorrhaphy by lateral implantation. 2nd step: Anastomosis of the two ends. (A, B) The two mesenteric segments, overlapping. (C) Line of suture of the two posterior edges. (D) Interior of the lower end. (E) Closed extremity of the lower end.

The button is used in the following manner: After having cleansed the cut edge of the intestine and the mucous membrane with a swab moistened with alcohol, a fine thread, passing through all the coats, is run around end A, for instance; then one of the portions of the button, held with suitable forceps, is introduced into the opening in the intestine, and the two ends of the running suture are tightened and tied, then the cut edges of the intestine are gathered around the central tube of the button.

The same manœuvre is repeated on end B: circumferential running

suture, introduction of the second portion of the button, adjustment of the intestinal wall around the central tube.

All that is then necessary for restoring the continuity of the two ends A and B is to press the two halves of the button together. (See Intestinal Obstruction.)

Before effecting the junction—which is final—certain important details demand careful attention: make sure that the orifices of the two metallic tubes are perfectly free, and that the intestinal edges and mucous membrane do not cover the entire surface of the entering tube, nor form a thick, irregular cushion, which might interfere with the proper approximation of the two parts of the button. Make sure also that the fixation of the intestinal ends around the separate portions of the button is secure; excise any redundant tags of tissue, and flatten down the folds which are to be brought into contact.

Then join the two portions of the button, but do not at once push them home; again make sure that no tag of mucous membrane is interposed; if so, it is still possible to flatten it out or bury it with the tip of the director. Finally, complete the junction by pressing the two portions firmly together; and during this final pressure be careful not to bruise or possibly even cut the intestinal wall by pressing on the central parts of the half-buttons; the pressure must only be applied over the rounded periphery.

Further, as Villard[1] has pointed out, there is no reason for fearing the interposition of a little mesentery between the two applied serous surfaces, and it is at least necessary that the mesenteric attachment should extend right to the groove formed by the two apposed surfaces; that is the essential condition for the nutrition of the two ends and their satisfactory union, and the only means of preventing gangrene and secondary perforation. A rapidly-applied continuous suture unites the two contiguous or overlapping borders of the mesenteric gap, and after cleansing, the loop is reduced. The presence of the button, however, may sometimes interfere with reduction and necessitate further incision of the ring.

The successful results from this method of anastomosis in cases of gangrenous hernia are sufficiently numerous to demonstrate its usefulness.

Whatever be the procedure adopted, the repaired loop will only be reduced after the line of union and the mesentery have been most carefully inspected, and after having made sure that nothing is bleeding, and that the apposition of the sero-serous surfaces is perfect. Then only, and after further careful cleansing, will the intestine be replaced in the abdomen; the sac, which also usually presents patches of gangrene, will be resected, and after rapid restoration of the abdominal wall, the operation will be completed by providing for drainage.

Primary enterectomy followed by immediate union in cases of gangrenous hernia should be employed whenever possible, and particularly

[1] Villard, of Lyons. "Traitement des gangrènes herniaires par l'entérectomie et le bouton anastomotique. Quatre cas de guérison." *Comptes rendus du Congrès de chir.*, 1895, p. 460.

when the gangrenous loop is still intact and unperforated, and has not discharged its contents into the cavity of the sac.

But it may be that any attempt at union, even with an anastomotic button, would take too long, or that unexpected difficulties have arisen during the course of the operation, even after the special intestinal portion had been begun; or more frequently, from the beginning one is compelled to admit: (1) *That the toxæmia is so deep that any prolonged operation must inevitably be fatal;* (2) *That isolated, and without equipment, one feels conscientiously unable to carry out the complete operation satisfactorily.* What can be done, and done quickly, in that case? **Make an artificial anus.**

Artificial Anus.—It is not enough to say "Make an artificial anus;" that instruction might be interpreted in various ways and as indicating various procedures. Whilst resigning himself to the makeshift, the surgeon must endeavour, on the one hand, to consider the future by giving the intestinal opening, if possible, a form and size compatible with subsequent easy closure, and on the other, to remove as freely as possible the focus of infection represented by the gangrenous mass.

If the loop is short, he may therefore content himself **with incising it along the free border, at the centre of the gangrenous area, and then attaching the edges of the opening to the remains of the sac and to the skin by a few interrupted sutures.**

Nothing, in fact, could be simpler, but that in itself is insufficient; it is also necessary to make sure that the channel through the upper end of the loop is free, and that the intestinal contents can escape by the opening without difficulty.

An immediate and copious discharge of intestinal contents need not be expected; it is chiefly gas which escapes at first, as the distended and paralyzed upper segment requires some time to recover its tonicity. Try, however, to pass a finger along each of the two limbs of the coil into the abdomen; if the passage is narrow, it may sometimes be possible to enlarge it by compressing the intervening mass of mesentery, which is itself flaccid and softened. If not, then the neck of the sac must be incised, but great caution must be exercised to avoid opening up the general peritoneal cavity through breaking down the adhesions too widely.

Carry the finger gently along the inner aspect of the sac, to seek for the neck, the tense strangulating band which you have already felt in the intra-intestinal exploration, and as far as possible bring the constriction into view by incising the skin and the sac on the corresponding side and by retracting the tissues, but avoid any extensive dissection, and for the actual division use the probe-pointed hernia knife. In such circumstances a free incision is unnecessary and would be dangerous; when the intestinal channel has become free, a large drainage tube will be placed in the upper end and fixed to the skin by a suture.

When the gangrene is of limited extent, as for instance when due to lateral strangulation (*Fig.* 175), it may occasionally be justifiable to do

something more, namely, to excise the gangrenous patch, and after free removal of the omentum and the sac, carefully to suture the margins of the excised portion of the bowel to the skin ; an artificial anus made in this way will be more satisfactory and more easily closed than the gaping, irregular cavities which result from a simple, haphazard opening. Such an artificial anus will, however, very seldom be necessary in these cases of partial gangrene, as they are singularly well adapted for primary resection.

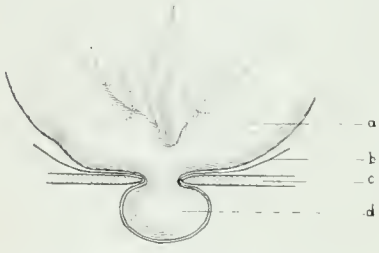


Fig. 175.—Lateral strangulation (diagrammatic). (*a*) Loop of intestine. (*b*) Parietal peritoneum. (*c*) Wall. (*d*) Strangulated portion of the loop.

Other measures are required when *a very long gangrenous loop* is found in the sac.

Simply to open it, would be to leave a considerable mass of gangrenous tissue to be eliminated spontaneously, and consequently to incur the risk of numerous septic complications, which would not always remain confined to the saccular and perisaccular areas, and that is a very grave danger, particularly in umbilical hernias. The abdominal cavity lies in such close proximity to the septic focus, that infection is likely to find an easy entry.

The wisest practice is to excise as freely as possible everything that is gangrenous : to excise the omentum, after ligation of the pedicle, without, however, separating the adhesions at the neck and without attempting to draw it out, to excise the greater part of the sac, and lastly, to excise the gangrenous intestinal segment. Two snips of the scissors would suffice to carry out the last part of the programme if the loop was always completely gangrenous ; even then it is necessary to divide the mesentery, and the mesentery always bleeds ; further, when the gangrene is not complete, but only in disseminated patches, the intestinal wall itself also bleeds.

Here, however, is no reason for refraining from a necessary resection, as a few very simple precautions will permit of a very large mass of intestine and mesentery being resected without loss of blood.

Bleeding from the small arteries in the intestinal wall can be readily controlled by forceps and ligatures, and hæmostasis will be completed by the sutures which will be afterwards introduced for the purpose of attaching the intestine to the skin. As to the mesentery, it can be secured before it is cut by the application of three or four ligatures, and by knotting together the ends of the two extreme ligatures it will be gathered up into a small stump, which acts as a plug in the abdomina lorifice of the sac, and at the same time approximates the two ends of the intestine.

The two ends of intestine are then rapidly fixed together by a few sutures passed through their adjoining mesenteric borders and attached by the rest of their circumference to the skin ; and here again make sure that the channel is sufficiently permeable, and if necessary relieve any undue constriction by a cautious incision.

Even in the most desperate conditions, one may in this way do better than by a simple incision; on two occasions I have succeeded in resecting, in strangulated umbilical hernias in old and deeply toxæmic women, the whole of a gangrenous transverse colon, an enormous mass of omentum, and a thick fatty sac, also greenish and putrid, and terminated the operation by suturing the two ends of intestine together by their mesenteric borders and attaching them to the skin; the whole procedure required only twenty or thirty minutes, and the patients recovered.

The ultimate result would, I think, have been very different had I left these masses of putrefying tissues in the wound, and depended on nature alone for their elimination.

III.—GANGRENOUS AND PERFORATED INTESTINE. FÆCAL ABSCESS.

The conditions are different when, on opening the sac, it is found that **the cavity is full of fæcal material and pus, and that the intestinal loop is more or less extensively perforated.** The first care must be to irrigate the sac and its contents with warm boiled water, carefully cleansing all recesses, and by separating and raising the covering layer of omentum, to bring into view and determine the nature and extent of the gangrenous patches.

If there be only one, or even several, *small punctiform perforations*, while the rest of the intestinal wall is in good condition, or again, if there be a single large gangrenous patch with a perforation at its centre, some reparative measure may be considered if there are no general contra-indications.

The margins of small perforations will be freshened and sutured, larger patches of gangrene invaginated or excised, and the resulting defects closed by suture. Then, if the loop has recovered a satisfactory appearance, it may be reduced, or retained in quarantine in the sac, after careful cleansing and after the constriction has been relieved. Of course gangrenous or contaminated omentum and sac will first have been freely resected.

It is evident that under such circumstances these operative measures cannot be carried out without very considerable danger of peritoneal infection.

Therefore, **when there is fæcal extravasation, the formation of an artificial anus will often be the only course** to pursue, and the operation must be performed in the simplest and most expeditious manner.

Open the sac freely, irrigate it, enlarge the opening in the intestine, make sure that the intestinal contents can escape freely, and if necessary make a small incision for the relief of constriction; introduce a large tube into the upper end of the bowel, suture nothing, leave the whole wound widely open, covered with moist compresses and a thick layer of wool, not too tightly bandaged:

that is all it is advisable to do. In these cases, the best treatment is that which involves nothing more than is absolutely unavoidable ; at the most it will be justifiable and useful to excise the gangrenous débris of omentum, sac, or intestine, without trenching on living tissues and without causing any bleeding.

We do not need to dwell on the bad prognosis of these late operations ; even if the patient survives, he still remains exposed to serious risks owing to the presence of a fæcal fistula at an unknown level in the length of the small intestine, and from which he can only be freed by means of operative measures which are always difficult and are themselves by no means without danger.

Fortunately gangrenous hernias are becoming less frequent in proportion as the sound principle of early operation becomes more generally accepted and the abuse of taxis is eliminated from daily practice.

THE RARE STRANGULATED HERNIAS.

We must here limit ourselves to some general remarks on strangulation and the necessary operation in (*I*) *Ventral*, (*II*) *Diaphragmatic*, (*III*) *Obturator*, (*IV*) *Sciatic*, (*V*) *Lumbar*, and (*VI*) *Perineal hernias*.

With regard to **epigastric hernias**, and **hernias in the linea alba** below the umbilicus, what has been already said about umbilical hernias is in all respects applicable.

We need only mention the frequency of a *presaccular lipoma*, the *thinness of the sac wall*, and lastly, in cases of strangulation, the *very tight constriction commonly met with at the ring*.

The following case will serve as an example of *epigastric herniotomy*.

Case 18.—The hernia was as large as an adult's fist, and formed a prominent swelling at the centre of the epigastric region ; it was of old standing, and had for a long time been irreducible ; symptoms of strangulation had appeared during the night, and taxis had been tried unsuccessfully some hours later. The patient—a man of 65 years—was collapsed, the pulse feeble, the facies bad, the pain very severe, and the vomited matter already brownish and fœtid. I operated at four o'clock in the afternoon, about twelve hours after the onset of the attack. I made a vertical incision: under the skin and a thinned, fatty layer, I found and carefully opened a *transparent sac*, through which the reddish-coloured contents could be seen ; a small quantity of blood-stained fluid escaped, and I found that the sac cavity contained only a single, long, blackish loop of small intestine. Beneath the intestine I discovered *a median circular ring, densely fibrous and very tight* ; with some difficulty I succeeded in slipping a grooved director under the upper margin and incised it with scissors, *directly upwards along the linea alba*. The loop of intestine was drawn out ; on each of the two limbs at the site of constriction there was a deep groove, and on the upper limb at the same level there was also a bleeding, longitudinal erosion, which was buried by bringing its margins together with a continuous suture of fine catgut. *Reduction. Extirpation and ligature of the sac.* The margins of the ring were excised and the opening was closed by three interrupted sutures. Recovery.

I.—VENTRAL HERNIAS.

These are the **hernias of the lateral wall of the abdomen**; they develop at the site of a subcutaneous musculo-aponeurotic rupture or in a cicatrix (traumatic hernia), or spontaneously, by insinuating themselves through openings in the linea semilunaris at the outer border of the rectus muscle.

The traumatic hernias, which almost always develop in cicatrices, are naturally situated at very various points in the abdominal wall, at the site of the original wound. They may become strangulated, and with them strangulation is particularly serious; I have seen two fatal cases.

Further, operation presents certain difficulties with which it is necessary to be acquainted in advance: the sac of a traumatic hernia is usually extremely thin, at least in its outer, bulging portion; *it is adherent to the cutaneous scar*, and the incision must be made with the greatest caution, particularly as in the sac itself adhesions of the contents, the omentum, and intestines, are very commonly present.

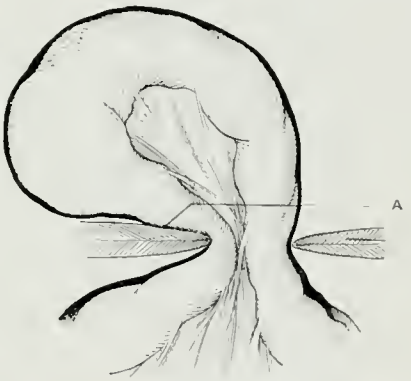


Fig. 176.—Strangulation by kinking in a ventral hernia. (A) Adhesions binding the lower end of the bowel to the ring.

The intestine itself may even be adherent to the thin cutaneo-saccular cicatrix; in the case of a butcher who had, the year before, received a knife stab in the left flank, I found a loop of small intestine fused for a considerable length with the hernial coverings; an extremely careful dissection was necessary in separating it, and in spite of all our care the intestinal wall was so thin in places that it tore; lateral enterorrhaphy was immediately performed, and the accident was followed by no ill effects.

The incision of the neck, which should be performed with the structures in full view, after the contents of the sac have been freed and drawn aside, and the repair of the abdominal wall, will be carried out in a manner similar to that employed in dealing with a strangulated umbilical hernia (*see above*).

In some cases the symptoms are produced by **acute kinking** of the intestine, as shown in *Fig.* 176; the opening in the abdominal wall is wide, there is no strangulation in the strict sense of the word, but one of the ends of the loop—say the lower end—is adherent to the corresponding margin of the ring, and at the fixed point becomes acutely kinked, and the progressively increasing distention of the upper end accentuates the kink and completes the obstruction.

As soon as the sac is opened, reduction can be achieved without much

trouble, often indeed without needing to incise the ring, but it is not complete or permanent unless care is exercised *to free the adherent intestine right into the interior of the abdominal cavity.*

This type of obstruction is peculiarly grave, for two reasons: (*a*) The obstruction is not absolute at first, the hernial swelling is not very tense, and the patient can still pass flatus; a diagnosis of pseudo-strangulation is made, and valuable time is consequently lost; (*b*) Taxis appears to give a positive result, the hernia is supposed to be reduced, but on the slightest effort the kinking recurs.

I cannot give a more striking illustration than the following:—

Case 19.—A lady, 62 years of age, who had been operated on twenty years before for an ovarian cyst, had since been affected with a whole series of hernial nodules in the abdominal wall. These multiple herniæ had repeatedly been the cause of symptoms of incomplete obstruction. Another and graver crisis developed: the obstruction was at first incomplete, the passage of flatus was not entirely suppressed, vomiting was infrequent, the swellings were not very tense and were in great part reducible. Meanwhile, however, stercoræmic intoxication advanced, the pulse and facies became bad, and on the fourth day, just before operation, a fæcal vomiting had occurred. A tense, painful hernial nodule, as large as the fist, and covered with thickened, reddened skin, situated below and to the left of the umbilicus, was evidently the seat of the trouble, the other swellings being indolent and completely reducible. Operation was performed; in the sac a reddened, distended loop of small intestine was found, kinked at a right angle over the right margin of the ring and adherent at the point of angulation; the adhesions were separated with the finger, and reduction was effected without difficulty; but the toxæmia had advanced too far, and the patient finally succumbed.

As to the **spontaneous hernias in the semilunar line** at the outer border of the rectus muscle, they sometimes form prominent swellings, or at least swellings which are easily recognized.

At other times, when the abdominal wall is loaded with fat, or on account of their interstitial—sometimes properitoneal—development, their presence may be indicated only by local pain and indefinite tumefaction, the exact nature of which is not perfectly clear; but in view of undoubted evidences of strangulation, there can be no question as to the urgent need for immediate operation.

We have seen two cases of strangulated hernia in the semilunar line.

Cases 20, 21.—The first occupied the left lateral wall of the abdomen, about three inches above Poupart's ligament: it was the size of the fist, and had been strangulated for three days. The patient, a woman 70 years of age, was in a most alarming condition; the facies, the feebleness of the pulse, and the coldness of the extremities indicated a condition of advanced septic poisoning. The very definite symptoms of strangulation, and the presence of the tense, dull, irreducible tumour, and the moderate superficial redness, left no doubt as to the diagnosis of a *strangulated lateral hernia.* I performed operation as a forlorn hope; a vertical incision opened a lobulated sac lying below the aponeurosis and a thin layer of muscle fibres; in the sac I found a large mass of adherent omentum and a long, very red loop of small intestine. The ring was very narrow and was situated exactly in the semilunar line at the outer border of the rectus muscle; it was bounded on the inner side by a very dense fibrous margin, which I divided with a probe-pointed bistoury; I then drew out the

pedicle of the loop, which, however, presented no serious lesions. After resection of the omentum, reduction was effected, followed by excision of the sac and rapid suture of the edges of the opening and the various planes of the abdominal wall. The patient succumbed a few hours later.

In my second case, the condition was supposed to be one of internal strangulation, and the hernia was discovered quite by chance in incising the abdominal wall with the intention of performing an enterostomy. It was one of those small hernias, embedded in fat and masked by the layers of the abdominal wall, which are always so difficult to recognize.

When symptoms of strangulation are present, the general rule must never be forgotten: **carefully explore all the hernial orifices, not only those of the ordinary hernias, but also the abnormal hernial regions,** and in particular the lateral wall of the abdomen, along and to the outer side of the rectus muscle.

Sometimes a little thickening or resistance, a localized pain, are the only appreciable signs, but associated with the general symptoms, such local signs ought always to attract attention and always deserve careful consideration.

An old case of Terrier's[1] is, in this respect, of very great interest. The patient, who presented some signs, at first not striking, of intestinal obstruction, had an inguinal hernia which was, however, perfectly reducible; but digital pressure within the left inguinal canal in the direction of the outer border of the rectus abdominalis provoked a rather severe pain, which radiated over the whole of the abdomen. Further, the patient indicated the same point as the site of some more or less acute spontaneous pains which, he said, gave rise to colic and nausea.

Nothing else could be discovered at the time by palpation; two days later, however, the condition became considerably worse, and before operation it was possible to feel "somewhat deeply, behind the abdominal wall, a fairly well-defined thickening which made one think that the obstruction to the passage of the intestinal contents was probably situated at that point."

Terrier performed sub-umbilical laparotomy, and on raising the left margin of the wound, he could easily feel, and indeed see, below and internal to the position of the internal inguinal ring, "a loop of intestine which appeared to penetrate into the anterior abdominal wall. This loop was enclosed in an actual sac with a resistant neck, which was, however, stretched without great difficulty with the finger." The strangulated loop was withdrawn; it measured about an inch in length, and at the site of constriction it bore a well-marked annular groove, but there was no sign of gangrene. "The cavity of the hernial sac was formed by a process of peritoneum, and was situated at the outer border of the rectus abdominalis muscle."

In these cases, **where the physical signs are too vague** to permit of a diagnosis, **median laparotomy** is the method of choice; it provides easy access to the pedicle of the hernia, if the incision is made sufficiently long to allow of eversion of the corresponding side of the abdominal wall.

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[1] TERRIER, *Bull. de la Soc. de chir.*, 1878, p. 361.

Before incising the neck of the sac—on the finger or with the probe-pointed bistoury—and withdrawing the intestine, the abdominal contents must be protected, and the area in which reduction must be effected carefully circumscribed with a large and thick compress, so as to minimize the risk of infection by any septic fluid which may be present in the sac or from contact with a gangrenous loop of intestine.

If a **local sign is present**, even though not very definite, **a direct incision over the swelling** is preferable, as it has the undeniable advantage of reducing the operation to a simple herniotomy.

II.—DIAPHRAGMATIC HERNIAS.

We have already described those traumatic hernias which immediately follow a wound or a rupture of the diaphragm, and which may become strangulated at once. (See THORACO-ABDOMINAL WOUNDS. WOUNDS AND RUPTURES OF THE DIAPHRAGM.)

The diagnosis is much more difficult when strangulation supervenes a long time after the accident, and still more so in the non-traumatic hernias, congenital or acquired.

From a diagnostic point of view, therefore, the cases fall naturally into two groups.

(*A*). At a more or less distant date there has been **a well-authenticated and severe injury of the diaphragmatic zone**; a cutaneous cicatrix is found; sometimes, indeed, certain functional disturbances, such as pains in the epigastrium and in the left hypochondrium, or attacks of dyspnœa or of pseudo-obstruction, have followed the injury.

These are points of the utmost importance which, in relation to a case of obstruction of obscure origin, ought at least *to indicate the possibility of a diaphragmatic hernia*, and direct attention to the base of the thorax.

The local examination will sometimes furnish confirmatory evidence, if the hernia is of large size; the base of the chest is enlarged, the apex of the heart is displaced to the right (in four cases out of five, a diaphragmatic hernia is situated on the left side); all the signs of a pneumothorax are discovered, but the pneumothorax has something unusual about it: the tympanitic area is not quite uniform, and it is broken up by irregular dull patches.

On this combination of signs and symptoms a diagnosis may be based sufficiently probable to warrant the adoption of the method of election, which is operation by way of the thorax, as a primary measure; this is, however, exceptional, as has been shown by various cases.

(*B*). In other cases **there is no indication, no history of a preceding injury**; all the symptoms of intestinal obstruction are present, but the cause is obscure.

The line of treatment is that which we have already advocated (see INTESTINAL OBSTRUCTION); **early laparotomy** is certainly indicated.

As to enterostomy, of course it cannot check the processes of strangulation and gangrene ; it will give only temporary relief, as in an instructive case recorded by Bérard and Gallois.[1]

The patient was a woman, 25 years of age, who had for six days passed neither fæces nor flatus by the bowel, and had vomited for three days. The abdomen was "universally and considerably distended, without evident predominence in any region." An artificial anus was made on the cæcum ; the distention disappeared, and although the temperature remained at 104°, the immediate relief was very marked. But two days later the patient suddenly felt "a sensation of tearing, with excruciating pain in the left side of the thorax ; she became livid, gasping," the pulse uncountable, the extremities cold, the temperature 97·8° ; an examination revealed all the signs of pneumothorax on the left side—a tympanic note at the base, amphoric murmur, metallic tinkling, and displacement of the heart to the right.

The patient was brought round, but the symptoms recurred in the evening ; thoracentesis was practised, and about four ounces of fœtid sero-purulent fluid, with a good deal of gas, were withdrawn from the chest. At the end of forty-eight hours the condition was still worse ; "there was considerable inflammatory œdema of the left thoracic wall. A fresh puncture gave issue to eight ounces of fæculent fluid, and by an incision in the 5th left intercostal space a considerable quantity of similar fluid, mixed with grumous fæcal matter, was evacuated." The patient lingered for thirteen days more, and then died.

At the autopsy a diaphragmatic hernia containing 44 inches of colon and sigmoid was found ; the intestine had perforated into the pleural cavity.

Even when laparotomy has been performed, the diaphragmatic hernia may not be discovered. On several occasions the abdomen has been closed or an artificial anus established after the cause of obstruction has been vainly sought for, and the hernia has only been discovered at the autopsy. Thus it was in a case recorded by Schwartz and Rochard.[2] "The exploration of the abdomen, which was rendered very difficult by the distention, gave negative results." The hand, introduced as deeply as possible into the left hypochondrium, detected nothing abnormal. An artificial anus was made on the cæcum. At the autopsy, the left portion of the transverse colon was found herniated through, and strangulated in, an opening situated right at the posterior part of the diaphragm.

The only conclusion to be drawn from such cases is this : in the course of a laparotomy for obstruction, where, notwithstanding a systematic search, nothing has been found, **the abdomen must not be closed until the under surface of the diaphragm has been explored as thoroughly as possible.**

[1] L. Bérard et E. Gallois, "Hernie diaphragmatique étranglée avec rupture du côlon dans a cavité thoracique," *Bull. méd.*, 1898, No. 11, p. 118.

[2] Schwartz et Rochard, "Contribution à l'étude de la hernie diaphragmatique étranglée," *Revue de chir.*, 1892, p. 756.

Since a diaphragmatic hernia is so difficult to discover by way of the abdomen, it is quite evident that the necessary operative measures cannot be carried to a satisfactory conclusion by that route; and although in some cases[1] the ring has been incised and the intestine reduced by the abdomen, as a rule it is to the **thoracic route** that the operator must turn.

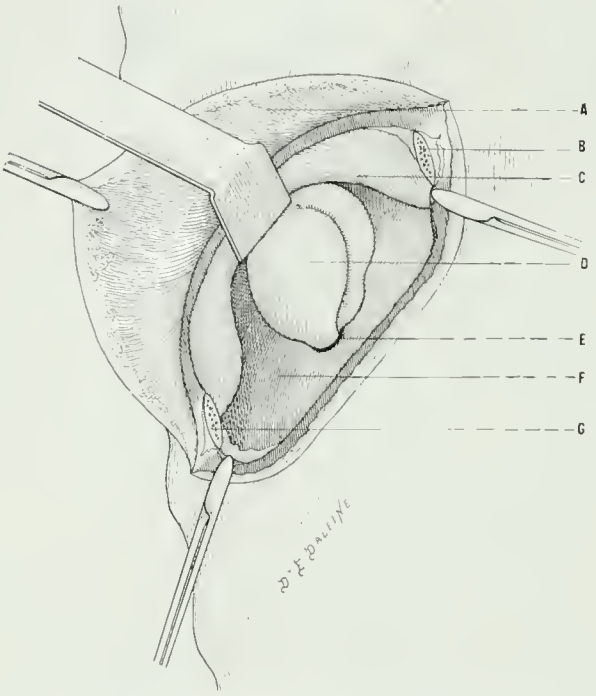

Fig. 177.—Operation for strangulated diaphragmatic hernia (trans-pleural route). (A) Flap turned up. (B) Posterior end of the 9th rib, resected. (C) Upper margin of the parietal pleura, retracted. (D) The herniated loop of intestine, without a sac. (E) The hernial ring. (F) The diaphragm. (G) Anterior end of the 9th rib.

Therefore close the abdominal wound except at its extreme upper part, through which is brought out the end of a large fold of gauze packed in beneath the diaphragm. On the left postero-lateral aspect of the thorax cut a large U-shaped flap, convex downwards, with its base on a level with the 8th rib and 4 to 5 inches long; dissect up the flap quickly, skin and muscles together, and lay bare the 9th rib and resect at least 4 inches of it. Then incise the parietal pleura freely (*Fig.* 177), and while the upper margin of the wound is pulled up strongly with a retractor, introduce a large roll of gauze like a tampon right to the bottom of the cavity.

One must not expect to find a hernial sac of the usual type; the sac is often lacking altogether[2] and the intestine lies naked, or only covered by a layer of omentum in the pleural cavity.

Efficient cleansing of the protruded viscera, the diaphragm, and the neighbouring pleura must always be the first care.

[1] *See* Blum et Ombrédanne, "Hernies diaphragmatiques d'origine traumatique," *Arch. gén. de méd.*, 1896, I, pp. 1 & 178.—Also Carl Raynart, "Ueber Zwerchfellshernien," *Inaug. Dissert.*, Freiburg-in-Br., 1900.

[2] In 276 cases of diaphragmatic hernia collected by Lacher, a sac was absent in 248 (89·85 per cent) and present only in 28 (10·15 per cent). (*Deutsches Arch. f. klin. Med.*, 1880, Bd. xxvii.)

Then the ring will be incised on the finger, which is slipped gently into the abdomen at the most accessible point; the herniated intestine or omentum will be drawn into the thorax under the eyes, in order that a careful inspection may be made of the constricted portion. After ligation and resection of the omentum, the intestine will be reduced if its condition is satisfactory, and then it only remains to effect a radical cure by closing the hernial orifice.

To do this, the methods already described for dealing with wounds and ruptures of the diaphragm must be followed; suture of the margins of the perforation, after freshening them if necessary, by interrupted sutures including as much of the muscle as possible; or, if the hernial orifice lies close to the thoracic wall, suture of its upper border to the lower edge of the parietal incision.

In the event of **the hernia being gangrenous**, what is to be done? A fæcal fistula discharging into the pleural cavity would be a most deplorable condition, and **primary intestinal resection and suture** is therefore necessary.

Once the intra-thoracic portion of the operation is finished, the packing which had been left below the diaphragm will be removed and the abdomen completely closed. Drainage of the thoracic wound will only be employed if the condition of the herniated viscera and the pleural contents make it a necessity.

III.—OBTURATOR HERNIA.

A strangulated obturator hernia is a particularly grave condition, and its gravity is increased first, *by the deep situation of the hernial swelling* and the frequency of diagnostic errors in consequence; and secondly, *by the difficulties and vascular dangers associated with operation.*

When the hernia shows itself as **a prominent swelling in the upper part of the adductor region, to the inner side of the femoral vessels,** it can be recognized on careful examination, without difficulty.

But it may be that the swelling is so small and so little apparent that it produces simply a diffuse tumefaction or asymmetry of the two corresponding regions. The search *for a localized pain, elicited by pressure at the inner part of Scarpa's triangle, near to the spine of the pubis*, on the inner and extreme upper part of the thigh, is then of great importance; *if the pain radiates definitely down the inner side of the limb to the knee*, the fact will be a further and valuable diagnostic point. This is Romberg's sign; it is due to compression of the obturator nerve, is rarely absent, and ought always to be sought for, particularly in doubtful cases where a direct examination gives negative results (interstitial obturator hernia).

In the female, the entrance to the obturator canal is accessible to vaginal palpation, and by carrying the finger forwards and laterally, it may be possible to detect at that position a localized pain, or even to recognize the existence of a swelling or a tense band, which is characteristic.

Lastly, the femoral and inguinal canals will be found to be free, or at least, if they are occupied by hernial protrusions, the hernias will be reducible and without any signs of strangulation.

Here it should be noted that, apart from the cases in which the obturator hernia has passed altogether unperceived, the symptoms being ascribed to intestinal obstruction, the most common mistake consists in confounding it with *a femoral hernia*, or with a femoral hernia of an unusual type, *the pectineal variety* for instance.

This happened in a very interesting case of Picqué's[1] : " At the extreme inner part of Scarpa's triangle there was a tumour, of small size, but easily appreciable on comparison with the corresponding region of the opposite side, which was markedly hollow. The swelling was deeply placed and could not be easily defined ; it seemed to be adherent by its deep surface to the underlying bone, at a point in the vicinity of the pubis ; it was tense and tender to pressure. At Poupart's ligament, over the femoral ring, a tender thickening was found which felt like a cord of omentum." The diagnosis was a femoral hernia of unusual type, probably pectineal.

In such circumstances, however, as M. Berger has remarked, the mistake is not serious, since the operation enables it to be immediately rectified.

It might be very different in a case where two hernias, femoral and obturator, were superimposed ; but simultaneous strangulation of two hernias appears to be an exceedingly uncommon occurrence, and if, in consequence of the mistake, femoral herniotomy had been first performed, the direct examination of the underlying region ought to clear up the diagnosis and indicate the precise seat of the strangulation.

However that may be, it is necessary to be aware of these rare conditions, and to be forewarned of the possible existence of a strangulated obturator hernia, and of the various and often indefinite forms which it assumes. The surgeon must search for it carefully, and in the presence of an inguinal hernia, and more particularly of a femoral hernia of unusual appearance and abnormal characters, must think of it, and conduct the examination with it in mind.

I need scarcely repeat that **taxis must be absolutely discarded** ; not only is its execution very difficult in the case of a hernia so deeply buried, and the pedicle of which is altogether beyond the direct application of the fingers, but the frequency of gangrenous lesions at the time, usually late, when surgical intervention is called for, makes it a dangerous procedure. The same must be said regarding traction on the herniated loop by the vagina, with the finger, when the condition has been recognized by vaginal examination.

Herniotomy is the operation of choice. Laparotomy must be considered as an exceptional measure, and has only been practised in cases

[1] Picqué et Poirier, " Etude sur la hernie obturatrice," *Revue de chir.*, 1891, t. xi., p. 693.)

where an error in diagnosis has been made. It must be recognized, however, that the technique of an obturator herniotomy is particularly difficult.

Without going too much into details of which the immediate practical usefulness is not very great, it is essential to have certain definite ideas regarding the anatomical relations.

An obturator hernia may present itself in one of three varieties: (1) *It traverses the whole length of the obturator canal* (*Figs.* 178 and 179) from behind forwards, emerges from the anterior orifice, and *spreads out in front of the external obturator muscle* and under cover of the pectineus; (2) Instead of emerging from the obturator canal by its anterior orifice,

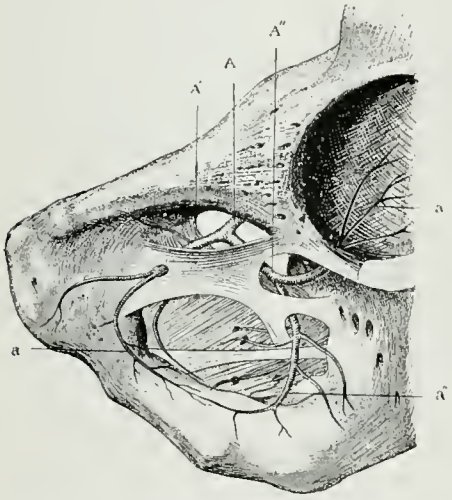

Fig. 178.—Obturator region seen from in front after removal of the muscles; the two layers of the obturator membrane are shown with the openings in them for the passage of the vessels (Poirier). (A) Main trunk of the obturator artery. (A'A'') Its two chief branches. Above, the orifice of the obturator canal gives passage to the main trunk of the obturator artery.

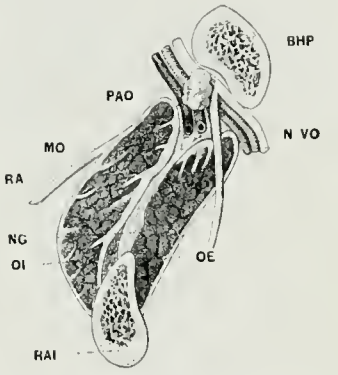

Fig. 179.—Section across the obturator region and canal (Poirier). (BHP) Section of the horizontal ramus of the pubis. (RAI) Section of the ascending ramus of the ischium. (MO) The obturator membrane, separated into two layers. (OI) Internal obturator muscle. (OE) External obturator muscle. (NG) The layer of fat between the muscles. (RA) Attachment of the levator ani. (NVO) Obturator vessels and nerves. (PAO) Plug of fat in the obturator canal.

the hernia engages itself between the upper and middle fasciculi of the external obturator muscle, and so becomes encircled and constricted by a double muscular band; (3) *The hernial sac burrows from above downwards between the two layers of the obturator membrane and remains entirely behind, and covered by, the external obturator muscle.* Under the pectineus no hernia is found, but a second muscular plane, and this second plane must be incised before the sac is reached. Other difficulties spring from the *intimate and very inconstant relationships of the obturator artery and its branches with the neck of the sac.*

In the first, the most common variety, where the hernia follows the whole length of the obturator canal, the obturator artery and nerve are usually situated behind the neck and a little to its outer

side ; this is the only point of any value which can be deduced from the many recorded cases, and even it has a very limited application.

There is, in fact, nothing constant in these vascular relations ; *the artery has been found on all sides of the sac* ; the neck has been found surrounded by a complete arterial circle ; nothing definite can be known beforehand, and cases of dangerous hæmorrhages caused during the course of attempts to relieve the constriction are not wanting to bear witness to this statement. Therefore, in performing an obturator herniotomy it is an invariable rule, and an absolute necessity, to provide as free access as possible, to deal with the neck of the sac only after it has been clearly exposed, after the position of the neighbouring arterial branches has been determined with the eye and the finger, and after ample room has been provided for controlling the bleeding if, in spite of all care, a large vessel should be wounded.

Technique of Obturator Herniotomy.—The patient's pelvis being raised by a thick pillow, the thigh flexed and moderately abducted, feel for the pulsations of the femoral artery, determine the position and direction of the vessel, and follow it down to the lower part of Scarpa's triangle ; **an inch and a half to the inner side of the artery make a vertical incision, at least four or five inches long, and commencing above at an inch below the pubic spine.**

Incise the skin, the subcutaneous tissue, and the deep fascia, avoiding the internal saphenous vein, which is sometimes met with, or dividing it between two ligatures if it is in the way. Look for the fibres, running obliquely downwards and outwards, of *the adductor longus*, and along the outer border of that muscle, the fibres of *the pectineus* ; open up the space between the two muscles with the finger and the grooved director, after having placed the outer lip of the wound and the great vessels of Scarpa's triangle in safety under a large retractor.

Now free the inner border of the pectineus from below upwards to its pubic attachment, and have it retracted in its turn ; if there is any difficulty in retracting it sufficiently, or if the region is laden with fat and access is inadequate, do not hesitate to make a short transverse incision in the muscle, or even to separate it partially from the horizontal ramus of the pubis. *Do not forget that it is the pectineus muscle which covers and hides the obturator region* ; it is only by retracting or incising it that the hernial sac and its neck can be sufficiently exposed.

The hernia will now become visible (*Fig.* 180) if it is of the commonest variety. Take every care to completely isolate it right up to its point of emergence. If the neck is surrounded by a collar of muscular tissue (2nd variety), carefully divide the upper portion of the band, that portion which is formed by the upper fasciculus of the obturator externus muscle, after having freed its deep surface. I have already stated that *in the third type*, which is, however, rare, *below the pectineus, a second muscular plane, the obturator muscle*, will be found, bulging forward, and tense owing to the presence of the underlying hernia ; in order to expose the sac, this second

plane must also be opened up, either by blunt separation in the line of its fibres, or better still, by freely dividing it.

The surgeon must not think of relieving the constriction by a primary external incision; he must open the sac first with the usual precautions, and after having first made sure by inspection and palpation that no aberrant artery runs over its anterior surface in such a position as to be injured when the incision is made.

After the sac contents have been examined and cleansed, prolong the incision upwards, with all the precautions described elsewhere; then try if the tip of the index finger can be insinuated into the neck, and by **stretching it downwards and inwards,** overcome the resistance of the tense fibrous ring. If the attempt fails, remember that in these hernias the constriction is always external to the sac, that it is caused by the edge of the obturator membrane, and it is that membrane which must be incised.

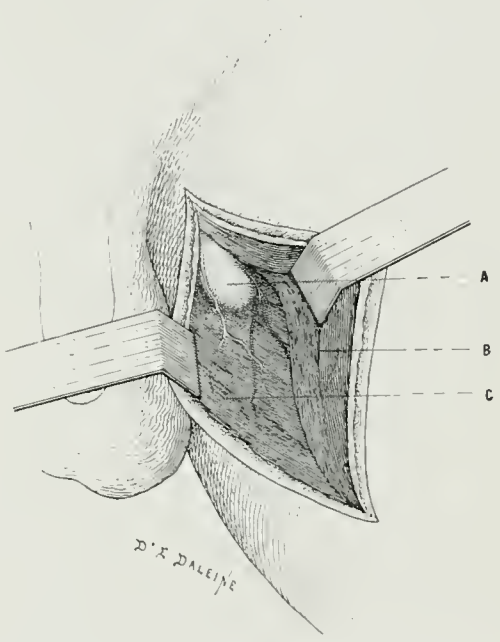

Fig. 180.—Obturator herniotomy. (A) Hernial sac and branches of the obturator artery. (B) The pectineus muscle: its inner border is raised and turned outwards. (C) Outer border of the adductor longus drawn inwards.

Therefore draw the sac aside and seek for a point outside it where no arterial pulsations can be felt, or better still, before taking up the knife make sure of the position of the obturator artery and its branches, so that they may be avoided. Incise the membrane in the extra-vascular zone with a probe-pointed bistoury, and under direct inspection; do not make a deep incision, but rather two or three shallow notches, sufficient to permit of the introduction of the tip of the finger, which can then complete the work by stretching.

It may be that *the neck is surrounded by a complete arterial ring*: if the condition is recognized, the best plan will be to make the relieving incision between two pairs of Kocher forceps, applied as high up as possible; on the other hand, the vascular arrangement may only be recognized on the occurrence of profuse hæmorrhage, which seriously complicates the operation.

Pack with gauze firmly and at once against the resistant plane formed behind by the obturator membrane, then gradually raising the packing try to see and catch the bleeding points. With some patience, and by

providing ample room, the attempt can be brought to a successful issue, and it will only very rarely be necessary to leave a gauze tampon in the wound.

The last steps of the operation present nothing special : extraction and inspection of the strangulated loop—lateral strangulation being very common,—repair if required, and reduction ; finally, ligation and resection of the sac, and if possible, closure of the anterior orifice of the canal by a few sutures.

It should be added that not only intestine and omentum, but also *the tube*, *the ovary*, *the appendix*, or *the bladder*, may be found in the sac of a strangulated obturator hernia. It is well to be aware of these possibilities, which may still further complicate an operation which is never easy. When there is gangrene or a fæcal abscess, the rules already laid down must be followed.

We have said that **laparotomy** is especially applicable to the cases of doubtful diagnosis. It will also be necessary to have recourse to it secondarily, when it is found impossible to relieve the constriction and to effect reduction by the external route. Naturally, in the first hypothesis, median sub-umbilical laparotomy will be performed ; in the second, the lateral incision at the outer border of the rectus muscle will be chosen.

If one is in a position to do it properly, the operation by the abdominal route will generally permit of more easy reduction, and will exclude the vascular dangers, but rigorous precautions are required to prevent peritoneal infection by the sac contents, which are always septic, particularly when the intestine is gangrenous and perforated.

The inclined or Trendelenburg position is very useful. The first step is to expose the obturator region thoroughly in a good light, and to isolate it with aseptic compresses ; then gentle traction will be applied to the herniated loop ; if that fails, the ring must be incised, but as the vessels are visible and the incision can be made under direct inspection, this step is no longer dangerous. The fluid contained in the sac is absorbed by the surrounding compresses, which should be changed at once. If the intestine is gangrenous, it will be brought outside and the necessary reparative measures executed, according to the invariable rule, "outside the abdomen."

The excision of the sac is impracticable by the abdominal route ; still, it will be possible to close the neck from within by some interrupted sutures. When the operation has been begun by the femoral route, and the abdomen has been opened secondarily, advantage may be taken of the first incision to perform a complete radical cure ; but it must be remembered, particularly in cases where time has already been lost, that it is necessary to work quickly, and to limit the operation to what is essential.[1]

[1] *See* L. Bérard, "De la hernie obturatrice étranglée," *Bull. méd.*, 1898, No. 23, p. 251.

IV.—SCIATIC HERNIA.

We shall deal very briefly with this rare form of hernia, referring to the works of Wassilieff,[1] of Garré,[2] an article of Berger,[3] and a recent monograph by Köppl.[4]

Fig. 181, borrowed from Garré's paper, will render an anatomical description needless; the hernia may emerge by **the great sciatic notch**, passing above the pyramidalis muscle (**supra-pyramidal hernia**, the most common) or below the muscle (**infra-pyramidal hernia**), or by **the small sciatic notch** (**sub-spinous hernia**). At these points the hernia acquires very important vascular and nervous relationships, notably in the supra-pyramidal variety with the gluteal artery. Sometimes it attains a very considerable size; more often it produces a diffuse fullness in the upper or lower part of the gluteal region; lastly, it may give rise to no appreciable swelling. The last-mentioned condition obtained in the case of Wassilieff's patient.

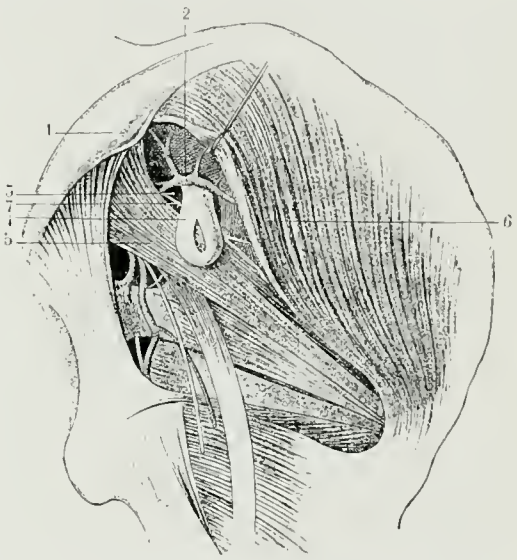

Fig. 181. — Relationships of a sciatic hernia (Garré). (1) Posterior iliac spine. (2) Gluteal artery. (3) Great sciatic notch. (4) The hernial sac opened. (5) Pyramidalis muscle. (6) Gluteus medius. (7) Superior gluteal nerve.

"The left gluteal region presented a normal appearance; there was no redness, no œdema, no swelling appreciable either on inspection or palpation. Pressure with the finger-tip caused pain only over a very limited area of the size of a shilling. This area was situated $3\frac{1}{2}$ in. from the median line, in the upper part of the buttock, over a line extending from the posterior superior iliac spine to the posterior part of the great trochanter." The usual hernial orifices were free; there were quite definite symptoms of intestinal obstruction, which were subsequent to the gluteal pain, which had occurred suddenly after a muscular effort.

[1] Wassilieff, "Sur la hernie ischiatique," *Revue de chir.*, 1891, p. 199.

[2] Garré, "Die Hernia ischiatica," *Beiträge zur klin. Chir.*, 1892, t. ix., p. 198.

[3] Article "Hernies" in *Traité de chirurgie* (Duplay & Reclus), t. vi., p. 370.

[4] E. Köppl. "Beiträge zur Kenntniss und Kasuistik der Hernia ischiatica an der Hand des ersten radikal operierten und geheilten Falles." (*Beiträge zur klin. Chir.*, 1908, lviii., 2, p. 314.)

I need hardly say that in the absence of an appreciable swelling the diagnosis will always remain somewhat uncertain: **the symptoms of intestinal obstruction associated with the presence of a localized pain in the upper part of the buttock, at the junction of the upper and middle thirds of the ilio-trochanteric line**[1], will then constitute the principal clinical points.

Sciatic Herniotomy.—Sciatic hernia appears to become strangulated fairly often,[2] and taxis cannot be recommended, although it has succeeded in Wassilieff's hands; as a rule, however, and particularly when the true nature of the condition has only been recognized at a late stage, it will be useless and dangerous.

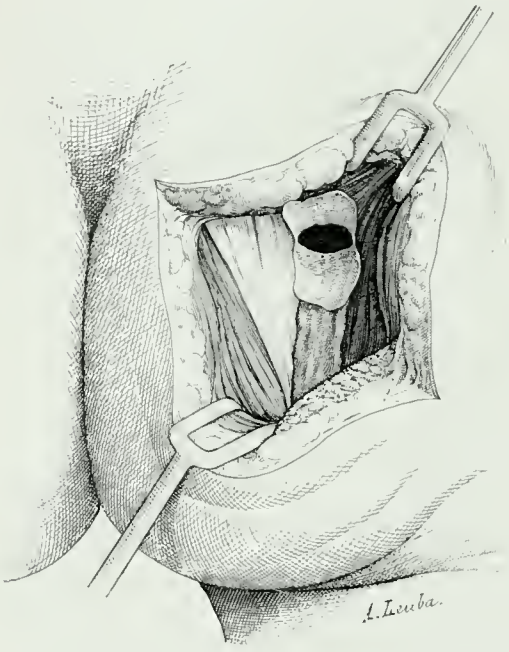

Fig. 182.—Sciatic hernia. Reduction has been effected. The hernial orifice is shown.

In performing the operation, abundant room is essential to exclude the risk of serious, possibly fatal, vascular injuries, which the indefinite rules regarding the position of the relieving incision are insufficient to prevent.

It has been recommended to make the incision of the constriction in a downward and outward direction, because **the gluteal artery generally crosses the upper border of the neck of the sac** (2, *Fig.* 181). That is true, but only in a certain proportion of the cases, and it is impossible to know beforehand if the particular hernia under consideration follows the ordinary rule.

It is necessary to make a large incision in the gluteus maximus and, by retracting the edges, to expose the whole of the underlying region (*Fig.* 182); **the incision will run obliquely, following the line of the muscle fibres from the posterior inferior iliac spine to the middle of the posterior border of the great trochanter**; it is, in fact, the incision for ligature of the gluteal artery, carried an inch or so lower down.

[1] The pain would be localized lower down, at the junction of the lower and middle thirds of the ilio-trochanteric lines, in the case of a sub-pyramidal or subspinous hernia.

[2] In 23 cases of sciatic hernia collected by M. Köppl, there was actual strangulation in 9.

Under the gluteus maximus the sac will be carefully isolated before it is opened, and the operator will seek to determine the position of *the bony margin of the great sciatic notch* above, and *the upper border of the pyramidalis muscle*, which crosses the whole of the deep plane obliquely from above downwards and outwards, below. The sac will then be opened, and a finger passed up to the neck will seek to **enlarge the channel by pressure downwards and outwards.**

If the constricting ring is very tight, it must be incised; but only after the position of the neighbouring vessels has been recognized by sight and touch, and always under direct inspection; here again, the constriction is best relieved by means of multiple shallow notches, followed by digital stretching.

Laparotomy has been performed by von Hacker in a case which, strictly speaking, appeared to be one of internal hernia in the neighbourhood of the great sciatic notch rather than a sciatic hernia.

The patient was a woman, 41 years of age, who presented all the signs of internal strangulation (intestinal obstruction of nine days' duration, fæcal vomiting). She had also a left femoral hernia, to which the condition was in the first instance ascribed, but herniotomy showed that it was not strangulated.

Von Hacker performed laparotomy the same day; he found a lateral strangulation of the ileum in a *peritoneal fossa, in the region of the great sciatic notch.* He succeeded in disengaging the intestine and closed the abdomen. The symptoms of obstruction immediately disappeared, but the patient died on the sixth day of broncho-pneumonia.

According to Langer,[1] this internal hernia at the entrance to the great sciatic notch ought to be considered as the first stage of a sciatic hernia.

V—LUMBAR HERNIA.

The lumbar hernias may occupy various points in the region bounded above by the last rib and below by the iliac crest, and extending from the erector spinæ muscle to the posterior border of the external oblique.

The following are the common sites: (1) **The triangle of J. L. Petit** (*Fig.* 183), bounded by the iliac crest *below*, the anterior border of the latissimus dorsi *behind*, and the posterior border of the external oblique *in front*; the floor being formed by the internal oblique and the lumbar fascia; (2) **The lumbo-costo-abdominal triangle of Grynfeld-Lesshaft,** situated at a higher level than the former, between the separated borders of the external oblique and the latissimus dorsi, and limited *above* by the tip of the 12th rib, *behind* by the anterior border of the quadratus lumborum, and *in front* by the posterior border of the

[1] A. Langer, "*Ueber einen Fall einer noch nicht beobachteten inneren Hernie (Hernia ischiatica incipiens),*" *in* von Hacker's *Chir. Beitrage aus den Erzherzogin Sofien-Spital*, 1892.

internal oblique; (3) **A gap in the external oblique muscle or in the latissimus dorsi** at their attachment to the iliac crest.[1]

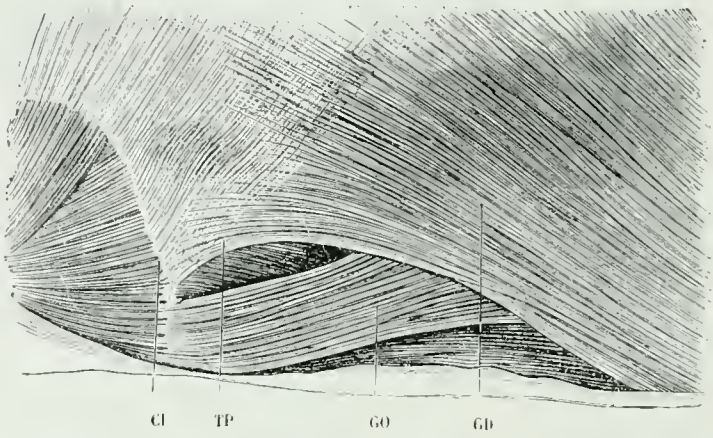

Fig. 183.—Triangle of J. L. Petit (right side).
(GD) Latissimus dorsi muscle. (GO) External oblique muscle. (CI) Iliac crest. (TP) Petit's triangle.

These hernias may become strangulated, and must be dealt with by operation, which, however, presents nothing special beyond the necessity for splitting or incising the corresponding muscular planes and afterwards restoring them by careful suturing. Strangulation occurs not uncommonly: in 49 cases of acquired lumbar hernia, M. Jeannel[2] found 9 cases of strangulation, a little more than 18 per cent. In these 9 cases reduction was effected by taxis in 5; operation was performed in 2 (Ravaton and Hume); in 1 case the patient died without anything being done; regarding the last case no details are given.

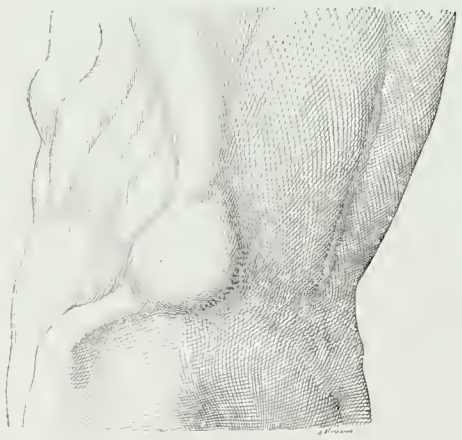

Fig. 184.—Strangulated left lumbar hernia.

The lumbar and lower intercostal arteries, which are

[1] See an anatomical study of the subject by R. von Baracz and A. Burzynski. "Ueber die Lendengegend mit besonderer Berücksichtigung der Durchtrittstelle der Lendenhernien," *Arch. f. klin. Chir.*, 1902, Bd. lxviii., 3, p. 658.

[2] Jeannel, "La hernie lombaire," *Archiv. provinc. de chir.*, 1902, Nos. 7, 9, 11, 12; 1903, Nos. 2, 3, 5.)

often encountered, need cause no trouble if care is taken to make a large incision and to perform an "open" operation.

It may be useful to quote two cases of lumbar hernia operated on by Ravaton and Hume; and I can add a case which was under my own care in February, 1905.

Ravaton's patient recovered, notwithstanding post-operative evisceration and serious septic peritonitis; she was pregnant, but went to full time and was delivered.

In the patient operated on by Hume, the hernia was very large and gangrenous, and appeared to have come through a slit in the latissimus dorsi, outside Petit's triangle. The patient, a man of 68, had had a hernial swelling as large as a fist in his left lumbar region for fifteen years. Symptoms of strangulation had been present for two days.

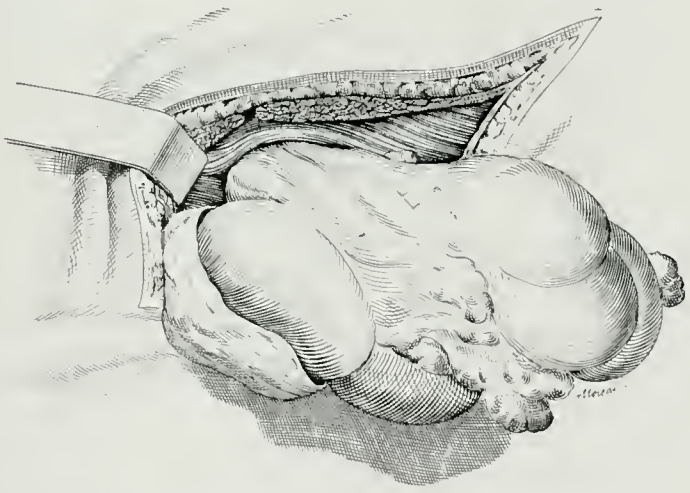

Fig. 185.—Lumbar herniotomy. Contents of the hernia; muscular ring.

The incision was made from the 12th rib to the iliac crest, and after the skin, the subcutaneous tissue, and a thin sheet of muscle, part of the latissimus dorsi, had been divided, the sac was exposed. It contained a gangrenous loop of small intestine and the sigmoid colon twisted on itself, and communicated with the peritoneal cavity by a slit-like orifice; two tense bands stretching from one side of the neck to the other had been the cause of the strangulation. After division of the bands, there was no obstacle to reduction, but it was first necessary to resect the long gangrenous loop of small intestine and to perform end-to-end enterorrhaphy. The sac was liberated and removed, and the peritoneal opening sutured with catgut. The patient died twenty-four hours later.[1]

[1] Hume. "A case of strangulated lumbar hernia." (*Brit. Med. Journ.*, July 13, 1899, vol. ii., p. 73.)

Case 22.—My patient was a miller, aged 65, who for twenty-five years had had a small rounded tumour, which caused no trouble, in the left lumbar region. During the last three weeks, however, the swelling had notably increased in size; it had become somewhat painful, and there had been colicky pains; for six days there had been obstinate constipation, and for three days not even flatus had been passed; there had been no vomiting, but a condition of continuous nausea; the abdomen was tense and tender, the pulse fast and weak, and the facies bad. A rounded, tense, tender and irreducible swelling, measuring 3 inches in each direction, was situated very definitely in the position of Petit's triangle, and descended below the iliac crest (*Fig.* 184). Operation was undertaken forthwith; an incision was made from above downwards and from without inwards, and immediately after, having passed through a thin aponeurotic layer, I came down on a fatty mass, in which I recognized the large intestine and

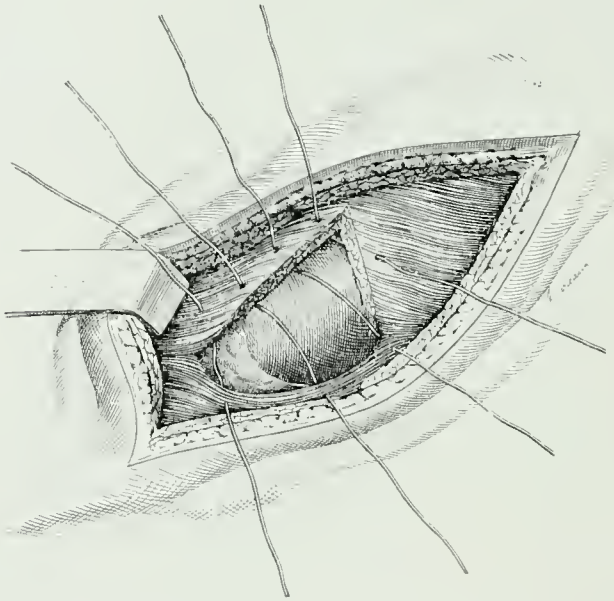

Fig. 186.—Lumbar herniotomy. Restoration of the muscular plane.

some lobulated fat, which represented the mesocolon; there was no sac. The intestine and the accompanying fatty tissue emerged from the abdomen through a very tight muscular ring (*Fig.* 185), which was incised in an upward direction; reduction was then possible, and was effected, after I had satisfied myself as to the integrity of the intestine. The separated borders of the divided muscular ring were then reunited by four points of suture (*Fig.* 186); the aponeurotic layer and the skin were sutured separately. The patient made an uneventful recovery.

VI.—PERINEAL, LABIAL, VAGINAL, AND RECTAL HERNIAS.

These are all hernias which come through the floor of the pelvis; they are very uncommon, but for that very reason may be the cause of grave mistakes and dangerous misconceptions.

Without entering into a discussion as to their causation, we may say that they all seem to have their point of departure in Douglas' pouch, the peritoneal cul-de-sac which separates the bladder from the rectum in the male, and the uterus from the rectum in the female. It is the peritoneum of Douglas' pouch which is pushed down and forms the sac, by insinuating itself along the anterior or posterior borders of the levatores ani or by forcing itself through a gap in one or other muscle, at the same time displacing the rectal or vaginal wall.

Perineal and Labial Hernias.—They make their appearance, in the male, laterally between the anus and the scrotum, or behind and to the outer side of the anus, not far from the lower border of the gluteus maximus; in the female they usually occupy the posterior third of the labium majus (pudendal hernia), and the pedicle may be felt by vaginal examination.

Vaginal and Rectal Hernias.—The vaginal hernia (elytrocele) presents itself in two forms, both of which are very liable to undergo strangulation: (1) The posterior vaginal wall is pushed down in its whole extent and forms what appears to be a large rectocele; a rectal examination, by demonstrating that the rectal wall is not involved in the protrusion, provides a point of primary diagnostic value. (2) The hernia is pedunculated, and is attached by a narrowed portion to the posterior vaginal fornix; it might be taken for a polypus. The latter variety has naturally a greater tendency to become strangulated.

A rectal hernia (hedrocele) is covered by the anterior wall of the rectum, which it pushes farther and farther down towards, or even out through, the anus, and presents the appearance of a rectal prolapse or polypus.

One point requires emphasis with regard to these two forms of hernia into the body cavities; it is this: they may remain in the rectum or vagina, attracting no attention, and they may pass undetected, the symptoms being ascribed to an intra-abdominal lesion. The simple but very important conclusion to be drawn is, that in the **presence of symptoms of obstruction a complete rectal and vaginal examination must never be omitted.**

SECTION X.—THE EXTREMITIES.

DISLOCATIONS.

We cannot enter into a complete discussion of the subject of dislocations, but will only give a practical description of the methods of examination and reduction; and we shall endeavour by comments on the drawings and photographs to indicate the various types, and the manipulations necessary for reduction.

I.—Dislocations of the Clavicle.

Dislocations of the Inner Extremity.—These are uncommon injuries; they may be **presternal, retrosternal,** or **suprasternal.** They are as a rule easily recognized, thanks to the prominence and shape of the displaced inner end of the bone. A fracture at the inner extremity of the clavicle may, however, give rise to some uncertainty; in a case of fracture, the bony prominence, projecting forwards or upwards, is irregular, the measurement from the bony projection to the acromial angle is less than that of the opposite clavicle, and reduction is difficult.

Reduction requires a double manœuvre: **displacement of the shoulder backwards and outwards,** to enlarge the acromiosternal interval; **direct pressure** on the dislocated extremity. As a rule it is easy.

Let the patient be seated on a low stool or across a chair. An assistant, standing behind, presses his knee against the interscapular space, and placing his two hands over the patient's shoulders, draws them *backwards and outwards* (*Fig.* 187). The surgeon, standing in front, rests his fingers on the sternum, the base of the neck, or the other clavicle, and presses with both thumbs on the prominence caused by the luxated extremity, which projects in front of the manubrium, or above it into the suprasternal fossa. The pressure is applied in the axis of the clavicle, either *upwards and outwards* or *directly outwards*, according to the nature of the displacement.

If the dislocation is of the **retrosternal** variety, an attempt must be made to pass the tips of the index and middle fingers behind the displaced extremity, and to draw it in a forward and outward direction towards its proper position.

If the surgeon is single-handed, the best plan is to make the patient lie down on a hard mattress with the shoulder projecting unsupported over the edge; the shoulder is then pushed upwards and backwards with one hand, while with the fingers of the other direct pressure is applied to the dislocated inner end of the clavicle.

The displacement has usually a very troublesome tendency to recur after reduction; retention is always difficult and often impossible. The double crossed shoulder bandage shown in *Fig.* 273 is particularly to be recommended. Little confidence can be placed in the various complex forms of apparatus which have been devised for the purpose of exerting continuous pressure on the end of the bone after reduction; apart altogether from the fact that their efficacy is always doubtful, they involve the risk of local complications, and the results which may be expected are insufficient to compensate for the disadvantages which follow their long-continued application. Massage, commenced forthwith and employed for a considerable time, is much to be preferred. And we may add that even when considerable deformity remains, the functional restoration may be almost complete; I have seen two cases of dislocation of the inner end of the right clavicle, the one forwards, the other upwards, of several years' standing, which in no degree impaired the working power.

Fig. 187.—Reduction of a dislocation of the clavicle. Retracting the shoulders upwards and backwards.

Dislocations of the Outer Extremity.—These may be supra-acromial or subacromial.

The supra-acromial variety is the most common of all the dislocations of the clavicle; it is very often easily reduced, but retention is always difficult and sometimes impossible.

Here again, to effect reduction, *draw the shoulder* or have it drawn by an assistant, *upwards, outwards, and backwards*, and at the same time apply pressure with both thumbs on the prominence of the dislocated clavicular extremity, pushing it *downwards* and *inwards*.

The deformity disappears and the bone slips back into its place, usually without difficulty if the shoulder is well retracted, but as soon as the pressure is released the dislocation reappears in spite of any bandages.

However, if it is only a simple dislocation, the matter is not serious; though some deformity may persist, there will be no permanent disability.

It is different when there is *irreducible overlapping*; the acromio-sternal axis is shortened, the shoulder falls forwards and downwards, and there is a considerable limitation of movement.

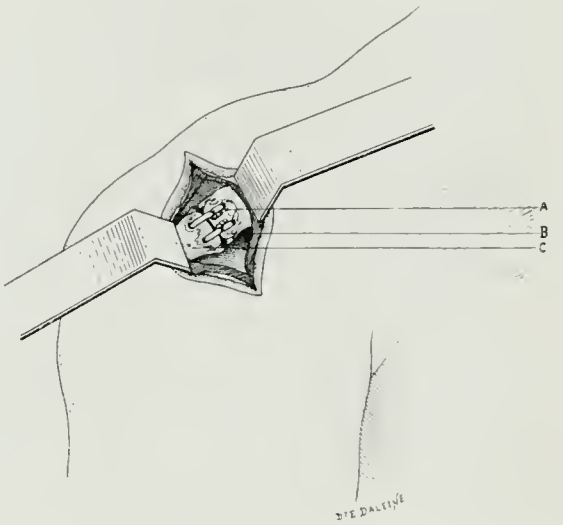

Fig. 188.—Acromio-clavicular suture. (A) Silver wire suture. (B) Outer extremity of the clavicle. (C) Anterior border of the acromion.

These points constitute the indications for **open reduction and acromio-clavicular suture**; the operation has sometimes been practised after the lapse of several weeks from the time of injury, in despair of rectifying the condition by other means, but it is always advisable to perform it at once under the conditions which we have just mentioned.[1]

Make an incision about 1½ inches long, over and parallel to the line of the acromio-clavicular joint; if this incision does not give enough room, it may be augmented by a second one along the posterior border of the clavicle.

Expose the site of dislocation, the torn fibres of the acromio-clavicular ligaments, and the dislocated extremity of the clavicle; remove the cartilages from the articular ends of the bones, and, if necessary to obtain complete reduction, excise a little of the clavicular end with the gouge forceps. Take particular care that the opposed surfaces are in broad and regular contact.

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[1] Poirier et Rieffel, "Mécanisme des luxations sus-acromiales de la clavicule: leur traitement par la suture osseuse." *Arch. gén. de méd.*, avril, 1891.

With a drill (*see below on* REUNION OF FRACTURED BONES) bore two holes in the clavicular extremity one-third of an inch from the margin, bore two symmetrical and similarly placed holes in the acromion, and through the two pairs of holes pass two silver or silk sutures, which when properly twisted or knotted will insure accurate adjustment (*Fig.* 188). It only then remains to reunite the torn ligaments and periosteum with catgut sutures and to close the skin wound. The limb will be secured with Mayor's sling (*Fig.* 270) and massage and local movements begun on the fifteenth day.

A word with regard to the rare **subacromial dislocation.** Here again reduction will be effected by pushing the shoulder upwards and outwards or by pulling on the arm raised to a right angle, while the thumbs, by direct pressure from below upwards on the end of the clavicle, try to force it into position.

II.—DISLOCATIONS OF THE SHOULDER.

It is **the dislocation inwards, below or internal to the coracoid process,** which is almost always seen. The dislocation downwards—subglenoid—is occasionally met with; dislocation backwards—subacromial or subspinous—is very uncommon.

Dislocations Inwards and Downwards.

Examination.—No matter how apparently simple the case may be, a complete examination must never be omitted before any attempt at reduction is made.

Subcoracoid Dislocation (*Fig.* 189).—The shoulder is flat, the acromion unduly prominent, and below the tip of the acromion there is a hollow.

The arm is in a position of abduction; its axis, if prolonged, passes obliquely upwards and inwards, and crosses the clavicle about its middle; the elbow cannot be brought to the side.

Feel for the coracoid, which is often difficult to define exactly under the fat and œdema; if so, follow the anterior border of the clavicle from within outwards until the tip of the finger comes in contact with the prominence formed by the process—remember that it is situated vertically over the axillary fold—if need be, apply a measuring tape over the opposite clavicle, between the inner extremity and the coracoid process, and carry the measurement to the injured side.

Having found the coracoid, under it, or extending a little to its inner side, the prominence of the head of the humerus can be felt, rolling under the finger when the arm is rotated.

Carry the elbow outwards, and pass the hand along the inner aspect of the arm to the axilla; there the smooth, rounded head of the humerus will be felt, and becomes more and more evident according as the degree of abduction is increased.

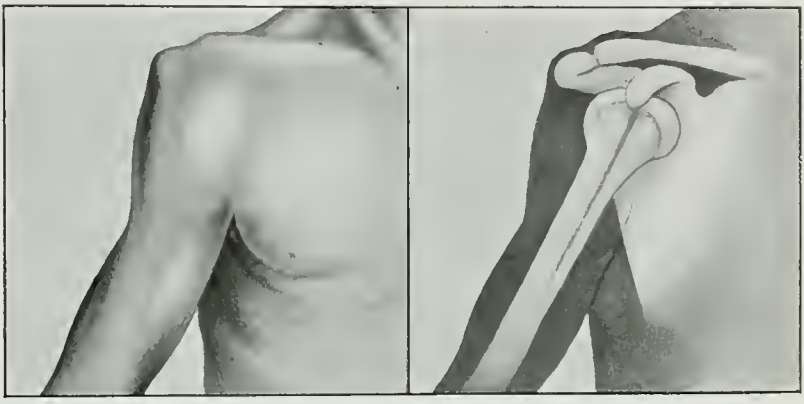

Fig. 189.—Subcoracoid dislocation.

Intracoracoid Dislocation (*Fig.* 190).—The elbow is but little separated from the trunk, and the axis of the arm is less oblique.

The head of the humerus can be felt almost entirely to the inner side of the coracoid, but by way of the axilla it can only be felt with difficulty even with the arm in extreme abduction.

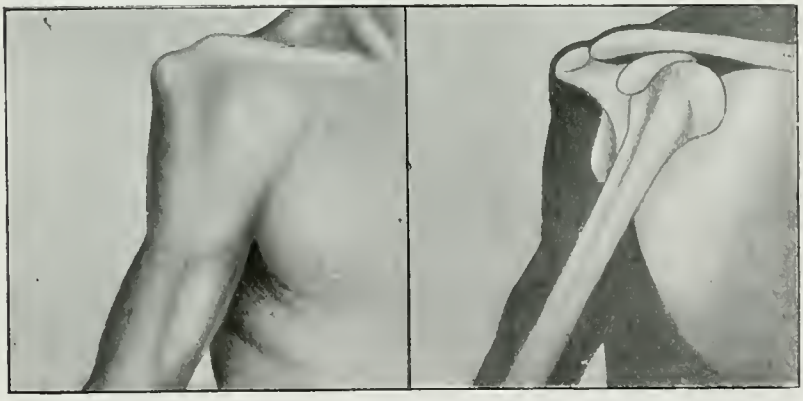

Fig. 190.—Intracoracoid dislocation.

A stage further and it is **a subclavicular dislocation;** the arm is applied to the side of the chest; the head of the bone shows itself far inwards between the clavicle, the coracoid, and the upper ribs; by the axilla it is inaccessible. It may even happen—though rarely—that the

head of the humerus perforates the pectoralis major and becomes subcutaneous below the inner third of the clavicle.

Subglenoid Dislocation. — The arm is in extreme abduction. (*Fig.* 191).

In the "**luxatio erecta,**" the elbow is in the air, the arm almost vertical, and the hand rests on the head.

The head of the humerus pushes down the floor of the axilla and forms a large prominence below the glenoid. A subglenoid dislocation is rare, but is typical and is easily recognized; it is readily transformed into a dislocation inwards.

As to the sub- and intra-coracoid dislocations, it is often difficult, in fat patients and when there is considerable swelling, to distinguish them definitely; the important point, however, is *to recognize that there is a dislocation.*

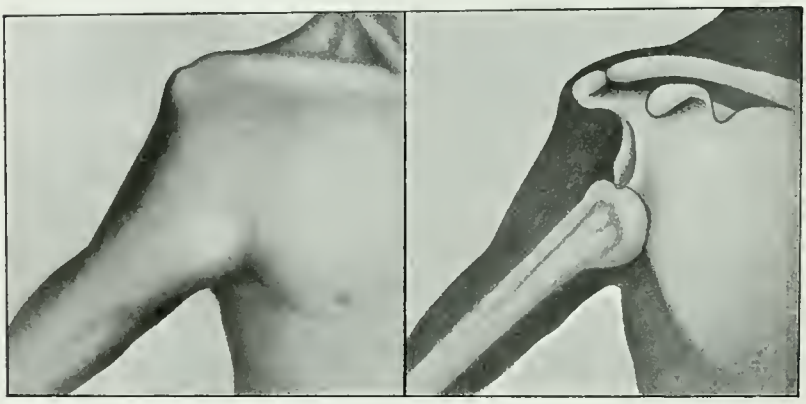

Fig. 191.—Subglenoid dislocation.

In doubtful cases, it is well to bear in mind the various traumatic lesions about the point of the shoulder which may produce a deformity similar to that of dislocation; dislocation or fracture of the outer end of the clavicle—fracture of the surgical neck of the humerus (*see below*)—separation of the upper humeral epiphysis (in young people dislocation is uncommon), fracture of the neck of the scapula (the point of the shoulder falls, the deltoid is flat and stretched, but if the elbow is raised vertically the deformity disappears).

There is another question which must always be considered: is the dislocation simple **or is it complicated by a fracture ?**—either a fracture by tearing away of the great tuberosity of the humerus, or a fracture of the glenoid, or a fracture of the upper extremity of the humerus ?

Is it complicated by **any nervous lesion ?**

Following the wise advice of Théophile Anger, do not forget to determine the condition of cutaneous sensibility over the outer part of

the shoulder, by pinching and pricking, before making any attempt at reduction ; if the skin over the deltoid region which is supplied by the cutaneous branch of the circumflex is insensible, you must conclude that there is a serious injury of the nerve trunk, and predict probable deltoid paralysis, and so free yourself from any responsibility.

REDUCTION.

There are two excellent methods which suffice for all reductions, if they are properly applied, and if the manipulations are varied a little to suit the exigencies of particular cases : (1) *Kocher's method* ; and (2) *Mothe's method* of traction with the arm in high abduction.

1. Kocher's Method.[1]

Subcoracoid Dislocation.—It is particularly in *recent* subcoracoid dislocations that this method finds its most useful application.

Make the patient sit sideways on a chair with the dislocated arm to the front ; an assistant, who need have no other qualifications than strength and obedience, applies his hands widely over the patient's shoulders and holds them steady.

The surgeon places himself in front and to the side of the dislocation, and after telling the patient to raise his head and to look straight in front of him, begins the reducing manœuvres gently and without haste.

1st step.—**The elbow is brought in contact with the side.**

Let us suppose that it is the left shoulder which is affected.

Grasp the patient's elbow firmly with your left hand, the fingers behind and the thumb in front, and while the right hand simply supports the forearm above the wrist, press the elbow steadily inwards *until it comes in contact* with the trunk, at the same time carrying it a little backwards.

The elbow ought to touch the trunk behind the axillary line ; this is a point of capital importance. The second step must never be begun until this contact has been achieved. If, in some hands, Kocher's method fails, it is because the attempt is made to carry it out too quickly ; each step in the process must be distinctly observed and executed completely ; *that is the only real way of working quickly.*

Do not be satisfied until perfect contact is obtained. It is the left hand particularly which is employed in this first step (*Fig.* 192).

Let us add that the movement must be executed without roughness and without jerking. Remember that muscular contracture is an important factor in the production of the resistance ; any violent manipulations will, by increasing the pain, simply serve to exaggerate the contracture.

[1] Or rather, to be strictly correct, the Lacour-Kocher method.

The muscles will only yield to a slowly and steadily applied force ; the patient suffers less and gradually relaxes himself.

Any time spent in completely carrying out and in prolonging the initial manipulations is always regained, and more than regained, in the end.

2nd step.—The elbow is held in contact with the side and the forearm is carried out into the transverse axis of the trunk. This

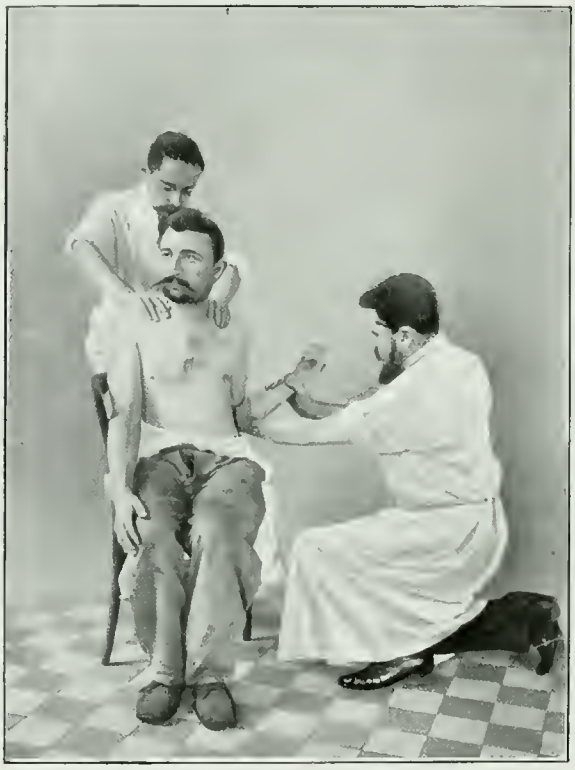

Fig. 192.—Dislocation of the shoulder. Reduction by Kocher's method. 1st step : The elbow is brought into contact with the trunk.

is the most important step in the whole process. In fact, Kocher's method might be termed the method of reduction *by rotation and elevation*, and elevation is useless if rotation has not been sufficiently complete.

The right hand is the active one in carrying out the second step.

Keep the elbow pressed to the side, and with the same gentle, slow, continuous movement as before, carry the wrist backwards until the forearm is at a right angle with the side of the body, or, in other words, until it is exactly in the transverse plane of the trunk (*Fig.* 193).

Here again, do not be afraid of exaggerating the movement a little, so long as the resistance does not become too great, but above all prolong it, and do not be in too great a hurry to pass on to the next step. Do not be alarmed at the loud crackling noises which are often heard, but watch the

Fig. 193.—Dislocation of the shoulder. Reduction by Kocher's method. 2nd step: The forearm is carried outwards into the transverse axis of the trunk.

head of the humerus, which shows itself prominently as it rolls outwards towards the shoulder. Not uncommonly reduction takes place at the end of this manœuvre, when it has been well and methodically executed, or perhaps at the moment of passing to the following one.

3rd step.—**Elevation: the forearm is maintained in the preceding attitude, and the elbow is carried upwards and forwards.**

Do not abduct the elbow; keep the forearm in the attitude in which it has just been placed, and raise the limb as a whole, carrying it upwards and forwards until the arm becomes horizontal, and pull on it while elevating (*Fig.* 194).

Elevation directly in the antero-posterior plane of the body is essential. There is always a tendency to carry the elbow a little outwards, but any

such abduction while elevating displaces the humeral head from the position of the rent in the capsule and interferes with reduction.

A sudden jerk, the special sensation felt by the patient, the alteration in the appearance of the shoulder, which may resume its normal shape

Fig. 194.—Dislocation of the shoulder. Reduction by Kocher's method. 3rd step : Elevation of the elbow.

while the elbow is being raised, will often indicate that the head of the bone has re-entered the glenoid cavity and that it is unnecessary to proceed further.

4th step.—Rotation inwards.

No result has been obtained ; then pass on to the 4th step, which must be carried out with a single sharp movement. It is important that the operator's hands do not change their positions during the course of the reduction.

Rotate the arm inwards, and carry the wrist across the front of the chest towards the shoulder of the opposite side (*Fig.* 195).

If reduction is not obtained, the whole procedure must be repeated, dwelling longer on the 2nd and 3rd steps, which must be carried out very thoroughly and without haste. It may be said that in simple and

recent subcoracoid dislocations, Kocher's method, properly applied, almost invariably succeeds.

But it is not the only method applicable, nor the only successful one; Mothe's method, which we shall describe immediately, also elastic traction

Fig. 195.—Dislocation of the shoulder. Reduction by Kocher's method. 4th step: Rotation inwards.[1]

in the abducted position, will give equally good results. These rational methods, correctly applied, suffice for all cases and are always and everywhere available; we shall therefore not even mention other methods, for the most part unduly forcible and empirical.

Intracoracoid Dislocation.—No great dependence can be placed on Kocher's method in treating this lesion;[2] it may, however, be tried if

[1] *Without violence.* I must here repeat that "force" must be carefully avoided in all manipulations intended to effect reduction. Further, this last step is merely the complement of the preceding ones; it is destined to give the last touch to the head of the humerus, which should at this stage be lying on the margin of the glenoid cavity, and it must be executed rapidly.

[2] Kocher's method is applicable as a rule to *all recent subcoracoid dislocations* and to certain cases of subcoracoid dislocation of longer standing. (See Ceppi, De la réduction des luxations sous-coracoidiennes invétérées. *Revue de chir.*, 1882, p. 82.) Occasionally, it is applicable to low intra-coracoid dislocations, as Kocher himself and Carafi have demonstrated, but always with certain modifications of technique. (Carafi, *Revue de chir.*, novembre, 1881.)

the surgeon is used to it and has thoroughly mastered the technique, with the addition of one or other of the following **complementary manœuvres**, both of which have been recommended by Kocher.

1. Prolong the second step, the rotation outwards, while **pushing the elbow as far back as possible**, always keeping it in contact with the trunk ; this extreme position can only be obtained by very slow and steady pressure (*Fig.* 196). Once it has been obtained, maintain it for one or two minutes, or even longer, until the tired muscles relax and allow the head

Fig. 196.—Intracoracoid dislocation. Reduction by Kocher's method.
1st complementary manœuvre: The elbow is carried as far as possible backwards.

of the humerus to descend, to disengage itself from the coracoid, and to sink towards the axilla. Then complete the manœuvre without modifying the exaggerated rotation which has been imparted to the arm.

2. Another variation, less efficacious than the foregoing, and which may be combined with it.

Apply the middle of a folded triangular bandage to the inner surface of the arm immediately below the axilla, pass the two ends round the arm and knot them together, and **with this band make traction on the neck of the humerus, directly outwards** (*Fig.* 197). By this procedure it is possible to disengage the head of the humerus and to transform an

intracoracoid into a subcoracoid dislocation; the bandage when pulled transversely outwards provides a point of support for the movement of the head of the humerus. If the head can be made to descend and to show its

Fig. 197.—Intracoracoid dislocation. Reduction by Kocher's method. 2nd complementary manœuvre. Traction outwards in the horizontal plane on the neck of the humerus is exerted by means of a folded towel.

prominence in front of the shoulder, the reduction will be completed by elevation of the elbow and rotation inwards as before.

But do not delay over these attempts if the first fails. The best method of reducing an intracoracoid dislocation is Mothe's,—in other words, traction on the arm in high abduction.

2. Mothe's Method by Traction in High Abduction.

It is applicable to all **inward dislocations**, and also to **dislocations downwards**. Counter-extension is indispensable and must be provided.

The two hands of a strong assistant encircling the postero-superior part of the shoulder and fixing the acromion may suffice, but it will be well to augment his efforts by the passive traction of a folded towel passed round the axilla and attached to some fixed point. There are different ways of arranging the towel; if it is placed with its centre over the axillary border of the scapula and the ends are passed transversely to the opposite

Fig. 198.—Well applied counter-extension; the acromion is fixed by the assistant's fingers and the outer border of the scapula by the folded towel.

side of the body, in front and behind the thorax, the upper part of the scapula will tilt outwards, and besides, the constriction of the chest becomes very painful.

One of the ends of the towel ought to be passed obliquely over the dislocated shoulder, as in *Fig.* 198. For additional security in troublesome reductions, the scapula may be more completely fixed in the following manner (*Fig.* 199): A folded towel is placed under the axilla, the two ends passing obliquely to the other side of the body; a second towel is applied over the acromion, and its two ends descending in front and behind are tied together under the seat of the chair; lastly, the operator places himself

somewhat behind the patient on the affected side, his right foot on the chair and the knee in the axilla against the border of the scapula, which is thus fixed and steadied ; both hands are then free to be used in the manner most convenient.

Once the counter-extension is fitted, proceed to the manipulations for reduction.

Fig. 199.- Counter-extension and fixation of the scapula by two folded towels and the knee.

The surgeon may, if necessary, stand on a stool or a chair to enable him to "dominate" the dislocated shoulder.

1*st step.*—With one hand grasp the lower part of the arm immediately above the condyles, and with the other simply support the flexed forearm ; raise the arm until it is in a position of high abduction in a line with

a prolongation of the spine of the scapula, and pull in that direction. Raise the limb steadily and slowly, keeping continuous traction on it in the line of its axis; one will sometimes be fortunate enough, in cases of subcoracoid dislocation in patients who are not very muscular, to see reduction occur during the course of this preliminary abduction, or as soon as the proper direction has been attained.

Fig. 200.—Dislocation of the shoulder. Reduction by Mothe's method. 1st step: The operator, with his hands at a higher level than the dislocated shoulder, exercises oblique traction on the arm upwards and outwards in the line of the spine of the scapula. In this figure, to avoid hiding the scapula, counter-extension is obtained by the arms of an assistant, whose hands cross on the outer border of the scapula, immediately below the axilla.

I must repeat: do not pull at a right angle, but only with the arm in a position of high abduction, forming an obtuse angle with the lateral wall of the trunk; that is the only direction in which traction can be usefully exerted. If additional power is needed, let an assistant apply his hands over the surgeon's to the patient's arm; but most important of all, use prolonged traction.

Follow the progress of the head of the humerus with the eyes as it gradually passes downwards and finally distends the axillary teguments ; if necessary, the traction may be continued by the assistant while the surgeon exercises direct pressure on the displaced head with his thumbs.

That is the first step (*Fig.* 200) ; fairly often, if the effort has been properly directed and sufficiently long continued, a sudden slip will indicate that reduction has been effected.

Fig. 201.—Dislocation of the shoulder. Reduction by Mothe's method. 2nd step : Turning the arm downwards and forwards ; in this case combined with horizontal traction on the upper part of the humerus.

2nd step.—But if not, then pass on to the second step ; **lower the arm suddenly, downwards and inwards,** in front of the chest ; this step must be executed without hesitation, with a single movement, and at the word of command, if traction is exerted by several persons.

I have repeatedly seen the manœuvre fail in consequence of the irregularity of the last step, although the head of the bone had been brought

well down and seemed quite ready to return to its normal situation. As a matter of fact, the failures of Mothe's method are usually due to one or other of the following reasons: (1) The traction has not been continued for a sufficient length of time, and has been interrupted before the head of the humerus has moved sufficiently far towards the axilla; (2) The arm is lowered badly, too slowly and too vertically.

When the head has been very far displaced and seems ready to slip away again, as soon as the traction is relaxed, the final movement of lowering the arm may be completed in the following manner: the two hands clasped around the upper part of the arm, pull it outwards, while the elbow is suddenly carried downwards and forwards (*Fig.* 201); when thus placed, the hands form a fulcrum which assists the outward movement of the head of the humerus.

Such is Mothe's excellent method, and one which is in no way inferior to Kocher's. It is the only method which should be employed in dealing with **subclavicular dislocations**; but the abduction must be effected gradually; the arm will be raised very slowly, while traction is exerted in the axis of the limb and as the head of the bone moves outwards, the right angle will be attained, then exceeded, and finally traction obliquely upwards in the line of the spine of the scapula will complete the reduction.

The same practice is applicable to **extreme degrees of intracoracoid dislocation**, in which reduction only becomes possible after the head of the bone has been pulled down and disengaged from the coracoid process. The following triple series of manœuvres must be carried out in succession.

1st step.—Grasp the elbow and the flexed forearm; carry the elbow gently away from the trunk[1] until the arm forms an angle of about 45 degrees with the side of the chest. Then pull on the humerus thus placed, in the line of its long axis; pull slowly and steadily, and if necessary get someone to help.

Of course it must not be expected that one is going to effect reduction, or even notably alter the position of the head of the humerus, by this traction at an acute angle; it is none the less useful, if sufficiently prolonged, in disengaging the head and starting the movement outwards.

2nd step.—As soon as the movement begins to be evident, as soon as the arm yields a little and the head of the bone begins to lift up the anterior wall of the axilla, raise the arm slowly to a right angle, keeping up traction all the time.

During this progressive elevation, it is sometimes useful, particularly if the dislocation is not quite recent, to make rotatory movements of the head of the humerus, alternately inwards and outwards, without, however, exerting undue force, and taking care not to inflict unnecessary pain on the

[1] In these extreme displacements, the arm is very tightly applied to the lateral aspect of the trunk.

patient if he is not anæsthetized, for it must be remembered that in such cases pain and muscular contracture go together.

These manipulations may undoubtedly serve to liberate the head and facilitate its descent, but if violently executed they extend and complicate the lacerations of the joint capsule, and therefore complicate the mechanism of reduction.

3rd step.—Carry the arm beyond the horizontal plane, and continue to pull, or make the assistant pull, at an obtuse angle with the trunk, in the proper direction,—that is, in the line of the spine of the scapula.

At this point it is very useful to assist the return of the dislocated head by **direct pressure.**

Fig. 202.—Reduction of a subglenoid dislocation. Counter-extension. Traction on the arm in high abduction; direct pressure on the dislocated humeral head.

Stand in front and to the side of the patient; clasp the hands over the affected shoulder, with the fingers resting on the external border of the acromion, which they help to fix, and the thumbs in the axilla against the prominence caused by the head of the humerus. Apply the thumbs carefully, as high up as possible, right at the bottom of the axilla, below and to the inner side of the displaced head, which is then pushed steadily upwards and outwards. To avoid compressing the axillary vessels and the accompanying great nerve trunks, determine their position by the arterial pulsations and apply the thumbs to the outer side of the vasculo-nervous bundle. Direct pressure is particularly useful at the end of the traction in increasing abduction, for the purpose of helping the final movement of the head of the bone into the glenoid cavity.

Dislocations Downwards, Subglenoid.—Here again, it is **Mothe's method** which should be employed, with the patient seated or, better, lying down, because the weight of the dislocated limb and the awkward attitude in which it is held tend to make the standing or sitting positions very uncomfortable.

Make the patient lie down flat on the back, with the shoulder projecting over the edge of the table; apply counter-extension in the way already described; grasp the arm above the elbow, and keeping continuous traction on the limb, gradually increase the abduction as before to an obtuse angle with the trunk, and then continue the extension in that direction.

These dislocations are not usually difficult to reduce; still, it is often useful to combine direct pressure on the head of the bone by way of the axilla, with the traction in high abduction.

Bring the arm into the proper direction, and then entrust it to an assistant, or two assistants if necessary, whose sole duty consists in keeping up steady, regular traction on the limb while the surgeon with the flexed fingers of both hands pushes the rounded prominence of the displaced head upwards and outwards (*Fig.* 202).

It will very rarely happen that these two manœuvres, applied simultaneously, do not succeed if sufficient time is given for the muscles to relax; if complete reduction is slow in taking place, it may be hastened by suddenly moving the arm forwards and inwards.

Dislocations Backwards.

The shoulder is flattened, particularly in front; there is a deep depression between the tip of the acromion and the coracoid process.

The arm is held a little forwards and is rotated inwards; under the angle of the acromion (subacromial dislocation), or further back still, under the spine of the scapula, the rounded prominence caused by the displaced head can be seen and felt.

The dislocation is almost always of the **subacromial** variety.

The surgeon stands in front of the patient and exerts **traction obliquely downwards, forwards, and outwards** on the arm, which is in a position of moderate abduction, forming an acute angle with the trunk; at the same time he increases the already existing internal rotation. There is an instinctive tendency to turn the arm outwards; external rotation gives no useful result.

The combination of these two movements will usually be successful.

If a good assistant is available, entrust the arm to him, and instruct him to keep the limb rotated inwards and to apply the traction obliquely. Meanwhile the surgeon, standing behind the patient, pushes the dislocated head downwards and forwards with his thumbs, as shown in *Fig.* 203.

The method employed by Nélaton père may also be tried; the arm is placed and held in a position of moderate abduction; a large seal well

padded with gauze is placed directly over the centre of the dislocated head, which projects below the acromion, and with a sharp blow the bone is pushed into its place.

Fig. 203.—Reduction of a subacromial dislocation.

The **subspinous variety** is very uncommon and requires to be reduced under chloroform.

After the patient is anæsthetized, the manœuvres just described are again employed : traction on the arm, combined with direct pressure on the dislocated head with the thumbs.

ELASTIC TRACTION (Théophile Anger's Method).

All forms of shoulder dislocation lend themselves to the application of this excellent, simple, and harmless method, which is almost invariably successful (I am speaking of recent cases) if it is properly carried out, that is, if the extension and counter-extension are applied correctly and for a sufficient length of time. The patient is seated, or if preferable, lying down ; in either case the method is the same.

First apply the counter-extension. The extension will be brought to bear on the arm above the elbow by means of a "**traction loop**" fitted as follows : Fold a sheet of flannel, a large handkerchief, or a towel

like a cravat ; apply the ends to the arm, one on the inner, the other on the outer side, leaving the loop projecting about a couple of inches beyond the olecranon ; with a soft, well-moistened bandage, make a first turn round the arm and the ends of the traction loop, turn back the ends and pass a second turn over them, raise them again and pass a third turn over them, and continue so to roll the bandage firmly round the arm till the limb is completely enveloped in its lower third at least (*see Fig.* 205). This is the best way of insuring that the traction band will not slip and will cause no injury to the skin. Or again, the middle of the folded towel may be applied over the postero-internal aspect of the arm, the two ends

Fig. 204.—Application of the traction loop.

brought round and crossed in front, then enveloped and fixed by turns of a moistened bandage ; the two ends of the towel are knotted and form the traction loop.

Either heavy rubber tubing or a long rubber band may be used. **The tube or bandage will be passed, on the one hand through the traction loop, and on the other through a ring, over a hook, or attached to any other suitable fixed point in the wall ;** the arm is raised to a right angle in a position of abduction, and the tube or bandage is drawn sufficiently tight, and the turns multiplied until adequate traction is exerted. It is unnecessary to increase the traction to the point of inducing pain ; the tension ought to be bearable, but sufficiently great to keep the arm from sinking down and to insure the extension acting in the proper line. The patient should be placed about a yard away from the external fixed point.

Pay close attention to the fitting of the apparatus; see that the traction loop does not slip, and make sure that the tension of the rubber tube or bandage is sufficient. The surgeon's part is then finished, and reduction will come about spontaneously. All that is necessary is to wait, and to encourage the patient to do the same, and to watch the movement of the dislocated head of the bone, without troubling about the congested appearance which the forearm soon presents. After ten minutes, a quarter of an hour, perhaps twenty minutes, reduction will be complete; the head of the humerus will be seen to return to its natural place, and there is nothing more to do but remove the elastic traction.

Fig. 205.—Elastic traction.

The usefulness of this essentially practical method no longer requires demonstration.

REDUCTION UNDER CHLOROFORM.

Lastly, in all cases where reduction presents any conditions of special difficulty, in dislocations of several days' standing, in dislocations complicated by separation of bony processes or by the presence of extensive hæmorrhagic effusion, in very muscular or extremely sensitive patients, **general anæsthesia** is a valuable resource, one indeed which should be employed as widely as possible. The complete suppression of muscular resistance, under the influence of a general anæsthetic, greatly facilitates the task of reduction and dispenses with the need for any complex manœuvres; traction in the abducted position, combined with direct pressure on the dislocated head (*Fig.* 206), suffices as a rule without the exercise of any great force. Of course, it is true that certain contra-indications to general anæsthesia must receive due consideration; it is equally true that the anæsthetic may need to be administered with special care; but one must not forget that under such special circumstances it is generally advisable to wait for complete resolution before interfering.

TREATMENT AFTER REDUCTION OF DISLOCATIONS OF THE SHOULDER.

The dislocation has been reduced; but the surgeon's responsibility is not at an end; the functional value of the limb must be restored, and with that object in view, appropriate treatment must be instituted forthwith.

In general, there is a great tendency to immobilize joints after reduction for too long a time, as if a recurrence of the displacement were always imminent. The resulting inertia adds its influence to that of the initial

Fig. 206.—Reduction of a dislocation of the shoulder, under chloroform.

injury in causing atrophy of the muscles and stiffness of the joint, and prepares the way for long-continued disability.

However, various possible conditions may occur:—

(1). **The dislocation has been simple and recent in a young healthy patient, and has been reduced without much trouble.**

Apply a Mayor's sling, but guard against keeping the arm fixed for more than three or four days. Then begin **passive movements and massage**: movements of flexion and extension, cautious abduction, rotation inwards and outwards; massage of the deltoid, the pectoralis major, the periscapular muscles, and the arm. The sittings should be repeated daily, and increased in length as time goes on; in the intervals the limb should be kept in the sling, but less and less fixed. At the end of

a week the sling may be removed altogether and the patient allowed to begin active movements.

I have seen cases of shoulder dislocation which had been treated in this way after reduction, recover full functional power by the twelfth day.

(2). **The dislocation has been complicated by considerable laceration** of the soft parts and extensive hæmorrhagic effusion; it has occurred several days previously, has been subjected to more or less rough treatment, and in the end reduction has only been effected with much difficulty.

In such a case there will be good reason for believing that the peri-articular structures have sustained serious injury, and that the torn capsule and ruptured muscles will not hold the replaced humeral head very securely in position during the days immediately following reduction. Not only is there danger of secondary passive displacements[1] of the head of the humerus, which being no longer sufficiently supported tends to slip down under the weight of the limb, but an actual recurrence of the dislocation may take place.

Care must therefore be exercised to secure the limb with Mayor's sling, properly pinned or stitched, and so applied, following Hennequin's recommendations, as to **hold the elbow in the direction of the dislocation**, forwards and inwards after an antero-internal dislocation of the shoulder, backwards and inwards after a posterior dislocation. **Keep the limb thus secured completely at rest for a week**, which need not, however, prevent gentle massage of the exposed shoulder after the lapse of three or four days.

But on no account prolong the immobilization beyond such time as seems absolutely necessary. Remember that these luxations with extensive injury of the peri-articular structures are exactly those which provide the conditions most suitable for the development of contractures, stiffness, and permanent disability; the only means of preventing such troublesome symptoms consists in the use of massage and local gymnastics, commenced early and long continued.

COMPLICATIONS OF SHOULDER DISLOCATIONS.

I shall only mention in passing the **compound dislocations** associated with an external wound and usually other grave lesions, and which are amongst the most serious articular injuries (see WOUNDS OF THE ARTICULATIONS). Elsewhere we shall consider the **dislocations complicated by fractures** and the immediate indications which they create (see FRACTURES OF THE ARM), and I shall not enter into the subject of **complicating nerve lesions** (ruptures of the branches of the brachial plexus or spinal nerve roots), but a short practical reference to the **vascular complications** is necessary.

[1] HENNEQUIN, "Déplacements secondaires passifs de la tête humérale consécutifs aux luxations de l'épaule en dedans." *Revue de chir.*, 1891, p. 154.

The ruptures may affect the **axillary artery or vein, and their branches**; isolated lacerations of the vein or of the smaller arteries give origin to huge extravasations of blood which may necessitate immediate operative intervention; but the most typical urgent situation results from a lesion of the main artery and the consequent immediate development of a **diffuse traumatic aneurysm.** In the case of a small tear or fissure of the artery, the aneurysm may only render itself evident after the lapse of a longer or shorter time.

The accident may occur at the time of the initial traumatism, with the dislocation, or during reduction when this is effected by forceful

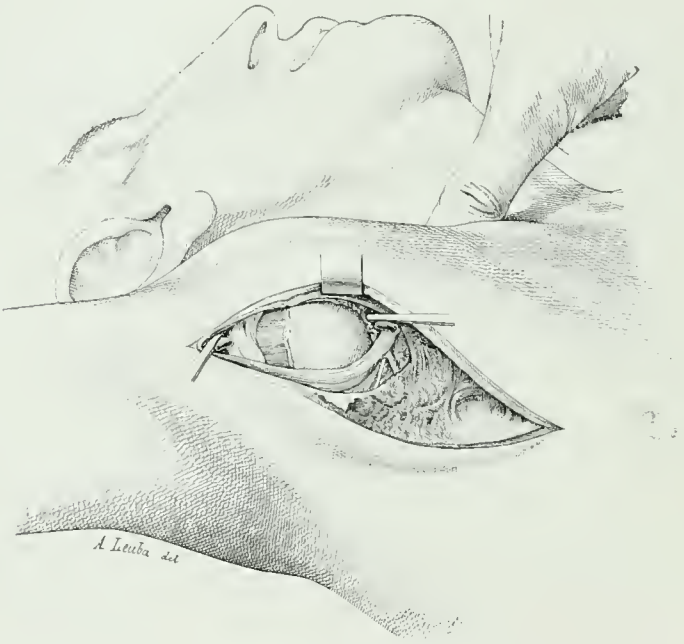

Fig. 207.—Operation in a case of shoulder dislocation complicated by rupture of the axillary artery. The two ends of the vessel have been caught with forceps; the head of the humerus lies exposed at the bottom of the wound.

methods, and particularly in old-standing dislocations; the accident was not very uncommon at the time when traction by pulleys was fairly customary. In old people and patients with atheromatous vessels it is always to be feared, and constitutes an additional reason for reduction under chloroform.

Let us consider a case in which rupture has occurred at the time of the dislocation. A man had fallen from a scaffolding; some hours later he was brought to hospital in the following condition: the right arm was in a position of abduction, the shoulder was flat, and the head of the humerus evidently dislocated, but the exact nature of the displacement and the probable existence of a fracture of the neck of the bone could not

be definitely established because of the presence of a large swelling which occupied the cavity and anterior wall of the axilla and extended up in front of the clavicle.

The whole region in fact was distended by an enormous and very tense accumulation, and over its entire surface pulsation was evident ; on palpation, the pulsations, which were perfectly synchronous with the arterial pulsations, were even more strikingly apparent, and on auscultation a soft, deep-seated, systolic bruit was heard. The swelling rapidly increased in size ; some hours later the axillary wall was so tense that it seemed to be on the point of bursting, the surface was smooth and reddened, the arm and forearm were already œdematous and insensitive, and the power of movement almost lost ; immediate action was evidently necessary if the patient's life and limb were to be saved.[1]

The gravity of such a condition is extreme, and necessitates a dangerous and very difficult operation, one which, however, will have the better chance of being successful the earlier it is performed. Digital compression of the subclavian artery is only a temporary resource ; ligature of the subclavian artery behind the clavicle is usually very difficult, and sometimes impossible under the circumstances, and gives only uncertain results. The best plan is to open the blood-containing cavity and to ligature both ends of the ruptured vessel (*Fig.* 207).

No preliminary attempts at reduction should be made. Digital compression of the subclavian artery is a useful precaution, or (if the supraclavicular region is not too much distended) the artery may be exposed and a temporary ligature applied ;[2] instead of tying the ligature, it may be used simply to raise and kink the vessel (*Fig.* 208).

A long incision is made over the lower border of the pectoralis major, the axilla is opened, and the clots which fill it are rapidly removed. And then begins the most dangerous and difficult stage of the operation. Here is the description of an actual case :[3] After clearing the axilla, a wound of the axillary vein was seen, and a jet of dark blood indicated a solution of continuity of the artery, which was due to the tearing away of a collateral branch. " We put forceps on each of the wounded vessels, and after having completed the clearing of the axilla, we proceed to ligate them, but while trying to do so, a jet of red blood inundated the whole field of operation. Rapidly we seized the artery at the apex of the axilla between the finger and thumb of the left hand ; then a pressure forceps was placed on the vessel at the point where it passed between the two heads of the median nerve. We relaxed the digital compression, and as there was no renewal

[1] Gangrene, in fact, was imminent. Gangrene has been known to occur some days after the accident, as a result of vascular lesions which had not given rise to any primary extravasation of blood.

[2] The ligature must be tied very gently ; it may readily cut the coats of an atheromatous vessel.

[3] It is the account given by M. Bousquet in his description of the following case : " Luxation de l'épaule gauche. Rupture de l'axillaire et de plusieurs vaisseaux de l'aisselle. Hémorragie. Ligature des vaisseaux lésés. Mort." *Bulletin médical*, 18 mars, 1905, p. 239.

of the bleeding, we concluded that the forceps had seized the vessel above the rupture. We then saw the head of the humerus lying exposed directly under the coracoid; we easily reduced the dislocation by direct pressure on the bone, while one of our assistants applied traction to the arm. We then discovered an incomplete tear on the outer aspect of the axillary

Fig. 208.—The subclavian artery exposed and kinked by a traction ligature passed underneath it.

artery; the head of the humerus resting on the vessel had partially occluded the orifice; this explained the persistence of the pulse which had been noticed. Ligatures were placed above and below the rupture, and then the other vessels to which forceps had been applied were ligated. The axilla was wiped out, the wound sutured and drained." The patient died suddenly a few hours later.

III.—Dislocations of the Elbow.

The **dislocation backwards,** sometimes backwards and outwards or backwards and inwards, is almost invariably the one seen.

Incomplete lateral dislocation, to the outer side particularly, is met with occasionally.

Lastly, an **isolated dislocation of the head of the radius** is by no means uncommon.

EXAMINATION.

1. **Dislocation Backwards** (*Fig.* 209).—Inspect the limb. The elbow is enlarged from before backwards; the olecranon shows itself posteriorly as a prominent projection, which becomes more evident on trying to flex

the joint, and is surmounted by a groove (tricipital groove). In front, the fold of the elbow is very deep, and is bounded above by a prominent rounded transverse ridge.

Follow the axes of the arm and forearm; their point of crossing lies in front of the posterior projection of the olecranon. Feel for the epicondyle and, about three-quarters of an inch below it, for the rounded head of the radius; it is no longer there; its place is empty, and it will be found posteriorly and recognized by its cup-shaped upper extremity. At the side of the head of the radius the olecranon is felt, and in recent and simple cases that is enough to settle the diagnosis.

When there is considerable swelling, the diagnosis becomes more difficult, and the points just mentioned are less definite: try first of all *to make sure of the position of the head of the radius*, and then to determine the relationship of the tip of the olecranon to the bicondylar line (the

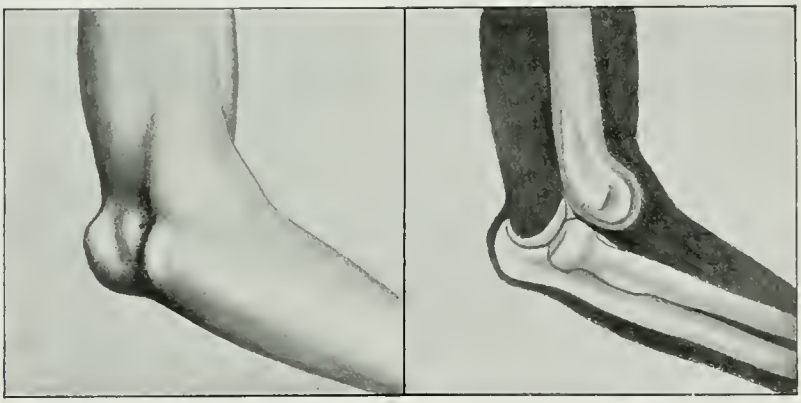

Fig. 209.—Dislocation of the elbow backwards.

transverse line joining the epicondyle and epitroclea) by comparing the injured elbow with the sound one. When the elbow is semi-flexed, the tuberosity of the olecranon lies well below the bicondylar line on the uninjured side; while on the injured side, the olecranon is on the same level as the bicondylar line, and if the forearm is extended, comes to lie notably above it. Notice also that though the forearm can be extended, flexion is impracticable, being prevented by a mechanical obstruction; on the other hand, if the lower part of the upper arm is fixed, extensive lateral movements can be obtained at the dislocated elbow.

If there is any doubt at all, think of a supracondylar fracture of the humerus; the olecranon and the condyles of the humerus then preserve their normal relationships, but the humerus, measured from the great tuberosity to the epicondyle, is shortened; on fixing the arm above the elbow and pulling on the forearm from behind forwards, the deformity disappears.

2. **Dislocation Outwards or Inwards** (*Fig.* 210).—In a case of incomplete dislocation outwards, the elbow is enlarged transversely and the forearm is usually pronated. On the inner side there is a large prominence which is easily recognized as the trochlea and epitrochlea.

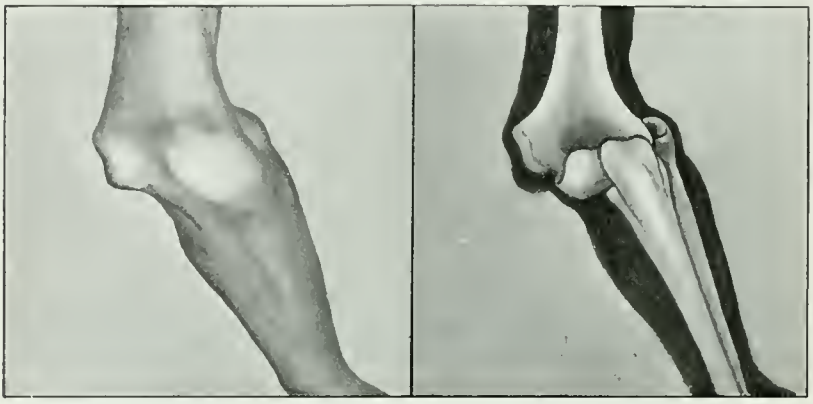

Fig. 210.—Incomplete lateral dislocation of the elbow, outwards.

On the outer side the displaced head of the radius can be seen and felt in front of the epicondyle; posteriorly the prominence of the olecranon shows itself, quite to the outer side.

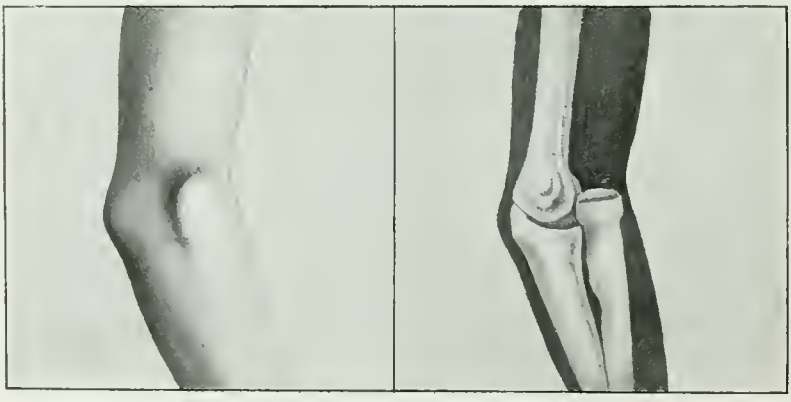

Fig. 211.—Dislocation of the elbow forwards.

Not uncommonly the epitrochlea is torn away; its absence from its normal position above the trochlea is evident, and sometimes it may be felt, freely movable, below.

In a complete dislocation outwards the deformity is very great and characteristic: below, and to the inner side, the projection formed by the whole of the exposed lower end of the humerus can be felt, and, above and to the outer side, the entire upper extremity of the bones of the forearm. These bony deformities are reversed in the very rare **dislocations inwards.**

3. **Isolated Dislocation of the Head of the Radius** (*Fig.* 211). —The condition is almost always a **dislocation forwards.** The outer border of the forearm appears to be shortened. Flexion is abruptly arrested, as if by contact with some solid obstacle.

Feel for the epicondyle; the space below it is empty, and the head of the radius is found in front.

An isolated dislocation backwards or outwards may also, though rarely, occur. The same method of investigation (the relationship to the epicondyle) permits of the recognition of the displacement.

The exceedingly uncommon **divergent dislocation,** ulna behind, radius in front, can also be easily recognized.

REDUCTION.

1. **Backward Dislocations.** —Let us take first the most common type: **Displacement of both bones directly backwards.**

The surgeon stands at the dislocated side, and raises the patient's elbow, grasping the arm with his two hands, crossing the fingers in front and applying the thumbs behind over the markedly projecting olecranon; in this manner **counter-extension** and **direct pressure** can be exerted at the same time (*Fig.* 212).

Traction on the forearm is applied by the assistant, first of all in the long axis of the extended upper extremity, then in flexion gradually increasing up to a right angle.

As a rule, reduction is very easily obtained by these two combined movements of **traction in increasing flexion** and **direct pressure from behind forwards.**

It will often be better to carry out the manipulations with the patient in the recumbent position (*Figs.* 213, 214). The foregoing is the method of choice, and is applicable to all dislocations backwards.

If the patient is very muscular, if the dislocation is of several days standing, and if it resists the first attempts, a **traction loop** will be fitted to the lower third of the arm in the manner already described, and by its means one assistant will provide adequate counter-extension, while another, or two if necessary, will apply traction to the flexed forearm, and the operator himself, standing to the outer side of the elbow, devotes his attention entirely to direct pressure on the olecranon. Some rotary

movements of the forearm inwards and outwards, or even lateral inclination to one side or the other, are sometimes useful preliminaries

One of the following manœuvres may also be tried :[1]—

The Method of Forced Extension.—Counter-extension is applied as before to the lower third of the humerus ; then traction is made on the forearm, first in the long axis of the extended upper extremity and then in **forced extension** at the elbow, and at the same time the olecranon and the head of the radius are pushed directly downwards and forwards.

Fig. 212.—Reduction of a backward dislocation of the elbow.

This plan will sometimes succeed, but it must never be forgotten that it is only suitable in dealing with young patients with supple articulations, that if carelessly applied it involves a risk of vascular injuries, and that it should, in fact, be only occasionally employed.

Astley Cooper's Method, with a Pad.[2]—Make a towel up into a roll about four inches in diameter, or better, take a rounded piece of wood

[1] It has been said that in recent backward dislocations of the elbow, any method will be successful. It is none the less true, however, that the simple, easy, and harmless method of direct pressure figured above ought always to be given the preference over any other.

[2] It is also known as the flexion method.

Fig. 213.—Reduction of a backward dislocation of the elbow. 1st step in the manipulations

Fig. 214.—Reduction of a backward dislocation of the elbow. 2nd step in the manipulations.

and envelop it in a towel; the rolled towel or piece of wood is placed transversely in the fold of the elbow, and serves as a fulcrum for the forearm bones in the subsequent manœuvres.

The two ends of the fulcrum are held to prevent it from slipping forwards; the patient's arm is fixed with the left hand, while the right hand holding the forearm above the wrist approximates it slowly and gently to the anterior surface of the arm, gradually closing the angle (*Fig.* 215).

Fig. 215.—Reduction of a backward dislocation of the elbow. Astley Cooper's method, with the pad.

The rationale of the method is evident: according as the long arm of the lever formed by the forearm is raised, the short arm formed by the olecranon is disengaged.

Astley Cooper's Method, with the Knee.—Let us suppose that it is the right elbow which is dislocated. The patient being seated, the surgeon places himself on the left side and puts his right foot on the chair; then taking the dislocated elbow, he applies its anterior surface to the front of his knee (*Fig.* 216), so fixing the humerus while he flexes the forearm, at the same time exerting traction on it in the line of its long axis.

As matter of fact, a lever action is here again the object in view, and reduction is produced by the same mechanism as in the last-mentioned

method. "The surgeon," wrote Astley Cooper, "placing his knee in the bend of the elbow, grasps the patient's wrist firmly and flexes the limb. At the same time he presses his knee against the radius and ulna in such a manner as to separate them from the humerus, so disengaging the coronoid process from the olecranon fossa; while this continued pressure is exerted with the knee, the forearm must be strongly but slowly flexed. Reduction is quickly effected."

When the relative positions of the surgeon and patient are correct—that is to say, when the patient is seated on a sufficiently low seat, and

Fig. 216.—Reduction of a backward dislocation of the elbow. Astley Cooper's method, with the knee.

when the operator's knee is at right angles to the anterior surface of the elbow—a considerable degree of force may be exerted, and it is possible to regulate well the great and localized pressure which is applied to the bend of the elbow.

Lastly, it is sometimes useful to employ **direct pressure with the heel of the hand.**

The patient lies down, and his arm is raised vertically. The surgeon passes his own left forearm into the bend of the patient's elbow, which he fixes firmly, and then applying the heel of his right hand to the olecranon, he pushes the displaced forearm back into position.

In our opinion the first method, traction combined with direct pressure, will suffice for all cases if properly applied.

In case of failure, notwithstanding carefully conducted efforts, it is always wiser, instead of employing forcible methods, to **anæsthetize the patient.** Under chloroform or ether the majority of the difficulties disappear, and the displaced articular extremities may be restored to position in the simplest manner and with the least possible damage to the peri-articular tissues, and as a natural result, functional restoration will be more complete and more rapid.

In dealing with a dislocation **backwards and outwards,** or **backwards and inwards**—that is, when there is an oblique displacement,—the line of action remains the same, with the single difference that the direct pressure on the dislocated articular extremities will be exerted obliquely.

2. **Lateral Dislocations.**—They may be complete or incomplete, and when recent can be reduced by **direct pressure combined with extension or lateral flexion.**

(*a*). Have traction applied in the axis of the dislocated forearm, and at the same time encircle the lower part of the arm with both hands, and applying the thumbs to the displaced articular extremities of the radius and ulna, press them gradually downwards and inwards. As the olecranon and the head of the radius slip downwards and approach their normal situation, it is a help to have the forearm progressively flexed; a final jerk under the pressure of the thumbs suddenly indicates that reduction has been obtained.

In this manner I have been able to reduce two complete external lateral dislocations of the elbow. I had the arm held, and grasping the elbow in my hands, I pushed the dislocated forearm strongly downwards, then inwards with my thumbs; the direct pressure sufficed to effect reduction without the need for any traction.

(*b*). The forearm is held by an assistant, and inclined towards the dislocated side, while the surgeon holds the arm, and as before presses first downwards and then inwards on the articular extremities of the forearm bones.

This direct pressure, conjoined with external lateral flexion, is the method of choice, and allows of reduction even when lateral dislocation is associated with separation of the epitrochlea.

The manipulations required for the reduction of **lateral dislocations inwards** correspond exactly to those just detailed. An assistant pulls on the dislocated forearm in the direction of its long axis, or inclines the limb laterally towards the inner side, while the surgeon presses the olecranon and the head of the radius downwards and outwards.

3. **Dislocations of the Head of the Radius, Forwards, Backwards, or Outwards.**—The forearm is entrusted to an assistant, with instructions to supinate and extend it, and to pull in the direction of the long axis of the limb, while the surgeon himself, by direct pressure with the thumbs on the radial head, tries to restore it to its place (*Fig.* 217).

The chief obstacle lies in the annular ligament, and though it may be overcome without much difficulty in recent dislocations, at the end of a few days reduction becomes very difficult, and often impossible even under chloroform. We have had proof of this in a case of anterior dislocation of the head of the radius in which excision of the displaced head was found to be necessary;[1] primary excision is indeed the best treatment in the event of failure to effect reduction.

Limits of space forbid any consideration of the very uncommon varieties. One general rule may, however, be formulated with advantage: in all abnormal dislocations, and in all those complicated by fracture or

Fig. 217.—Dislocation of the head of the radius.
Reduction by traction on the forearm and direct pressure on the head of the radius.

considerable effusion of blood, begin by anæsthetizing the patient before attempting any manipulations. Under general anæsthesia the exact nature of the lesions and the character of the dislocations will be more easily determined, and the most suitable measures adopted forthwith.

After all dislocations of the elbow, the rule of **massage** and **early movement**, which we have already expressed with reference to shoulder dislocations, is even more strictly applicable if the impairment of extension so common after injuries of the elbow is to be avoided.

[1] Sur le traitement des luxations anciennes de la tête du radius en avant. *Revue d'orthopédie*, 1 mars, 1898.

IV.—Radio-carpal Dislocations, Carpal Dislocations and Fractures.

Even though clinically a **dislocation of the wrist** may seem perfectly evident,[1] the correctness of the diagnosis can only be admitted after radiographic verification. I have seen two most characteristic examples of these apparently uncomplicated dislocations; the displacement was in the usual backward direction, the deformity was quite typical, and reduction was effected without difficulty; one of the patients, however, died a few days later, and at the autopsy it was found that the condition was in reality one of fracture, very low down, of the two bones of the forearm; in the other case, a subsequent radiographic examination showed a fracture at the base of the styloid process of the radius.

However that may be, when dealing with a case of traumatic deformity of the wrist, resulting from a radio-carpal dislocation backwards or—more rarely—forwards, the first duty is to reduce it; traction on the hand in the axis of the forearm, combined with direct pressure on the displaced bony projection, is the best procedure, and usually succeeds without trouble.

Nowadays we are well aware of the actual frequency of **fractures and dislocations of the carpus**; it is always well to keep them in mind when dealing with any case of injury of the wrist, and to remember that the grave functional disturbances which so often follow such injuries—which have been considered to be simply sprains—are very often due to unrecognized carpal lesions.

The dorsal dislocation of the os magnum, according to Pierre Delbet,[2] must be considered as the fundamental lesion; it is by no means always present at the time when the injured wrist is examined; in fact, it may not have occurred at all at the time of the injury, but a consideration of the mechanism of its production, and its various phases, furnishes the best explanation of all the anatomical varieties of displacement which occur.

The lesions are almost always produced by a *fall on the extended hand*: the fibres of the anterior ligament, which are attached to the os magnum, are first stretched and give way, and if the lesion goes no further, a simple sprain is the result; in some cases the scaphoid may be fractured.

A stage further, and the os magnum is dislocated backwards from the semilunar, which remains attached to the radius in its normal position; the dislocated os magnum carries with it the distal row of carpal bones, the scaphoid, and the cuneiform, which may be either intact or fractured; this is the typical dislocation of the os magnum without displacement of the semilunar.

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[1] See the monograph by MM. J. Abadie et E. Jeanbrau, "Les luxations radio-carpiennes traumatiques," *Bulletin médical*, 28 nov., 1903, p. 993.

[2] P. Delbet, *Bull. de la Soc. de chir.*, 1908, p. 377.

Very often the os magnum in passing backwards pushes the semilunar bone forwards; the latter bone tears itself completely away from its attachments, and turning over from behind forwards, slips out from its normal position under the radius, leaving a gap into which the head of the os magnum reduces itself spontaneously. The dislocation of the os magnum has therefore been the first phase; it has, as it were, begun the movement, and has then reduced itself, and the **displacement of the semilunar** constitutes the sole remaining evident abnormality. These are the cases which are usually termed dislocations of the semilunar.

Fig. 218 Dislocation of the semilunar and scaphoid. (Patient of Prof. Segond; radiograph by M. Infroit.)

The extent of the displacement of the semilunar bone varies: the amount of rotation from behind forwards may reach 90° or 180°; sometimes, indeed, the bone may even be carried upwards in front of the radius (*Fig.* 218).

Dislocation of the os magnum with complete separation of the semilunar is the most common type. Here is an instance of it.

Case 23.—A workman, 32 years of age, had fallen from a height of 10 feet, with both hands forward, the right in extension. We saw him eight days later; the right hand was greatly swollen and pronated, the fingers semiflexed; the

wrist was thickened antero-posteriorly; on its anterior aspect in a line with the third metacarpal bone, a little below the inferior border of the radius, a rounded and somewhat tender prominence, apparently about the size of a hazel-nut, could be felt, though not very definitely. The supposition of a separation of the semilunar was confirmed by the X rays, which also showed that the displaced semilunar bone had carried with it a small fragment of the cuneiform, and that the radial and ulnar styloid processes were both fractured close to their tips (*Fig.* 219).

I operated; a longitudinal incision was made over the front of the wrist, a little to the inner side of the middle line, the flexor tendons were retracted to either side, and in the depths of the wound the prominence formed by the displaced semilunar was seen. The bone was exposed by dividing and retracting the fibrous layers which still covered it, and with a periosteal elevator introduced under it from below upwards and from before backwards, the bone was detached and extracted. The wound was closed. The functional value of the hand was completely restored by the end of two months (*Fig.* 221). The semilunar was

Fig. 219.—Dislocation of the semilunar.

intact, but on either side a small fragment of bone had remained adhering to it; the fragment on the left belonged to the cuneiform, that on the right side to the scaphoid (*Fig.* 220).

In case of **dorsal dislocation of the os magnum without separation of the semilunar**, there is a "silver fork" deformity of the wrist, and the posterior projection formed by the head of the os magnum, and sometimes the scaphoid, can be more or less definitely made out.

Although it is possible in characteristic cases to make the diagnosis from the examination of the wrist, a skiagram is nevertheless almost always indispensable. After an injury to the wrist, the attitude of the hand, semiflexed and carried a little outwards, the depression below the lower end of the ulna, the very marked limitation of movements, particularly of flexion and extension, the antero-posterior thickening of the wrist, the

shortening of the carpus, and, lastly, the discovery by palpation of abnormal projections and irregularities on the anterior or posterior surfaces, ought always to arouse suspicion of the probable existence of a carpal lesion.

An exploration of the "tabatière anatomique" (the hollow on the back of the hand at the base of the thumb between the tendons of the extensor secundi and extensor primi internodii pollicis) will not be neglected: in the *isolated fractures of the scaphoid* a very definite painful point will be found there; further, it is sometimes occupied and filled by a bony projection, over which crepitation can sometimes be detected, and the base of the first metacarpal is evidently approximated to the tip of the radial styloid process.

Fig. 220.—The extirpated semilunar bone; note the small adherent osseous fragments.

What is to be done for these carpal injuries after the exact nature of the condition has been definitely recognized by clinical and radiographic examination?

In the case of a dorsal dislocation of the os magnum, without separation of the semilunar, with typical deformity and of quite recent occurrence, **reduction** will be attempted under chloroform. Traction will first be

Fig. 221.—Dislocation of the semilunar: radiograph after extirpation of the bone.

made in the axis of the forearm on the extended hand, then the hand will be gradually flexed, while at the same time pressure will be exerted from behind forwards on the dorsal prominence, and counter-pressure from before backwards on the lower extremities of the bones of the forearm, in such a manner as to induce the head of the os magnum to return to its natural position under the concavity of the semilunar.

If the attempt fails, it is best to proceed to operation at once without spending any more time over other indirect measures.

In cases of complete separation of the semilunar, operation is also the best method of treatment.

In all cases, the object of the operation will be to excise the semilunar bone, and with it, if necessary, any attached fragment of the scaphoid.

A longitudinal incision will be made over the front of the wrist along the inner border of the palmaris longus, and the anterior surface of the carpus exposed by incising between and retracting the flexor tendons (*Fig. 222*).

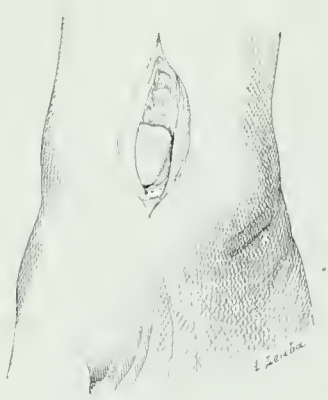

Fig. 222.—Median incision for removal of the displaced semilunar.

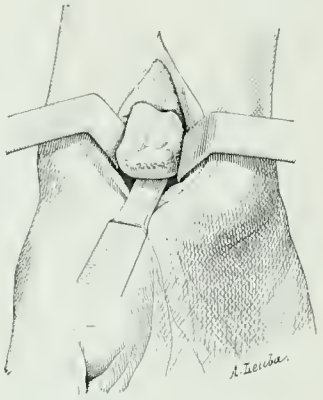

Fig. 223.—Freeing the semilunar bone with the elevator.

If the semilunar bone is displaced, any remaining fibrous attachments will be divided, and the bone can then be enucleated by means of an elevator slipped underneath it from before backwards (*Fig. 223*).

When it has remained in position, the operation is a little more troublesome ; it must be remembered that the semilunar bone is attached to the radius by two ligaments, an anterior and a posterior, which must be divided before it can be removed. The wound is closed, and movements of the hand begun at an early date.

V. Dislocations of the Thumb.

There are three varieties of posterior metacarpo-phalangeal dislocation : they are **incomplete** when the glenoid ligament and sesamoids still rest on the head of the metacarpal ; **complete** when the glenoid ligament lies vertically on the dorsal aspect of the metacarpal ; **complex** when, the phalanx having been turned straight again, the glenoid ligament is interposed between the dislocated phalangeal extremity and the dorsal aspect of the metacarpal.

Incomplete Dislocation (*Figs.* 224 and 225).—Never yield to the instinctive tendency to try to effect reduction by simply flexing the thumb and turning down the phalanx.

Take a firm grip of the phalanx, raise it a little, at the same time bending it a little further backwards, then push its upper (proximal) extremity downwards and forwards; in this way the dislocated extremity, with its attached glenoid ligament and sesamoid bones, is compelled to return by the way which it had followed in the process of dislocation.

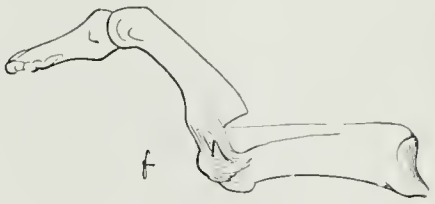

Fig. 224.

Simple incomplete dislocation of the thumb. (Farabeuf).

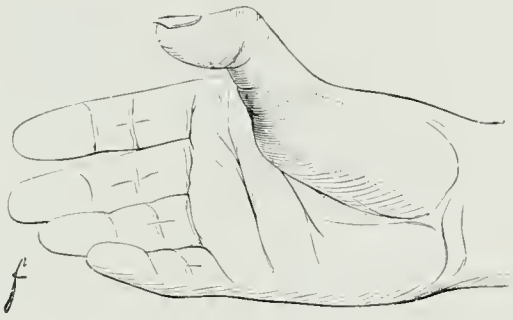

Fig. 225.

Simple incomplete dislocation of the thumb. The deformity.

Complete Dislocation (*Fig.* 226).—It is particularly in these cases that flexion is to be avoided, as it is sure to convert the comparatively simple complete dislocation into the *complex variety*, reduction of which is always difficult.

Grasping the vertically placed thumb in the whole hand, incline it still further backward, and then push its upper end (the end which lies in contact with the metacarpal) obliquely forwards and downwards; the dislocated

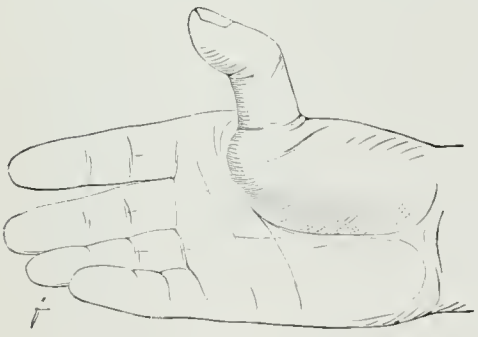

Fig. 226.—Simple complete dislocation of the thumb. The deformity. (Farabeuf)

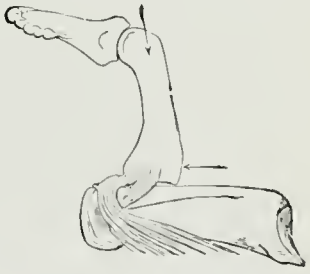

Fig. 227.—Simple complete dislocation of the thumb. Reduction. The arrows indicate the directions in which the pressure must be applied to make the phalanx slide along the metatarsal, pushing the glenoid ligament and sesamoid bones in front of it. (Farabeuf.)

extremity must always go first, and must be kept closely applied to the metacarpal bone; as soon as the glenoid ligament has passed the margin of the articular surface, reduction follows (*Fig.* 227).

Fig. 228.—Complex dislocation of the thumb. The glenoid ligament is turned back and caught between the ends of the bones. (Farabeuf.)

Fig. 229.—Complex dislocation of the thumb. The deformity. (Farabeuf.)

Complex Dislocation (*Figs.* 228 and 229).—Anæsthetize the patient if there is no reason against so doing; follow carefully the method described by Farabeuf: "Begin by pulling on the thumb in its long axis until its natural length, or even a little more, is restored; then, without relaxing the tension in the axis of the metacarpal, turn the thumb backwards to a right angle; this step disengages the glenoid ligament and the sesamoid bones, and places them edgewise on the back of the metacarpal." Then execute the manœuvre just indicated for dealing

Fig. 230.—Reduction of a complex dislocation of the thumb. 1st step: Traction in the axis of the thumb.

with a complete dislocation: slide the phalanx from behind forwards along the dorsal surface of the metacarpal; the phalanx pushes the

glenoid ligament and the sesamoid bones in front of it, and following them, recovers its natural position.

Fig. 231.—Reduction of a complex dislocation of the thumb. (2nd step.)

In reduction, the following steps are to be observed :—

1*st step.*—Pull on the thumb in its long axis, until it recovers its normal length (*Fig.* 230).

Fig. 232. Reduction of a complex dislocation of the thumb (3rd step.)

2*nd step.*—Raise it, holding it as represented in *Fig.* 231, the fingers below, the thumb above at the base of the 1st phalanx, and turn it

backwards until it is *perpendicular to the metacarpal,* or even a little beyond the vertical.

3rd step.—Do not flex it nor turn it forwards again ; keep it vertical (*Fig.* 231), and push it from behind forwards along the dorsal surface of the metacarpal, against which the base of the phalanx is kept firmly pressed.

4th step.—Push it in this manner as far forwards as possible, then depress it without any sudden flexion (*Fig.* 232). Apply your own thumb

Fig. 233.—Method of reducing complete dislocations of the thumb, simple or complex. (Farabeuf.)

over the base of the 1st phalanx, and keep pressing the latter forwards while depressing it.

Farabeuf's forceps are very useful, particularly in certain cases where the thumb is short and œdematous and gives a very poor hold. *Fig.* 233 shows excellently the manner of using the instrument, and obviates the need for any explanation.

Notice that the important step in the process is the turning back of the phalanx into a position *at right angles to the metacarpal :* it is during the course of this movement that the sesamoid bones and the glenoid

ligament are disengaged ; if it is incomplete, or if the pushing forward is commenced too soon, reduction will not be obtained.

Carry out the whole procedure thoroughly and carefully, repeat it two or three times if necessary ; if still unsuccessful, and particularly if the dislocation has occurred some days previously, and attempts have already been made by others, do not persist. On no account try forceful methods, nor, following the example of some people, thrust a tenotomy knife down to the phalanx and blindly divide everything that appears to interfere with reduction ; **perform a dorsal arthrotomy and open section of the glenoid ligament,** as recommended by Farabeuf and Verneuil.

Make an incision about an inch in length through the skin—properly washed and disinfected, of course—along one side or the other of the extensor tendon, over the prominence formed by the luxated phalangeal extremity ; divide the underlying cellular tissue, retract the extensor tendon and the edges of the wound, and definitely expose the focus of dislocation, the posterior extremity of the phalanx and—right at the

Fig. 234.—Dislocation of the thumb, forwards and outwards. (Farabeuf.)

bottom—the back of the metacarpal bone, covered with a thick, whitish, fibrous plate, in which the two sesamoid nodules are embedded. The fibrous plate is the glenoid ligament. Using a short, strong knife, split the ligament longitudinally in the middle line ; cut right down to the back of the underlying metacarpal bone and to the lower border of the articular surface of the phalanx (*Fig.* 236). If the ligament is very dense and resistant, it may be necessary to combine two small transverse nicks, made close to the base of the phalanx, with the longitudinal incision.

It has been proposed to divide the glenoid ligament subcutaneously ; the puncture is made at the inner side of the extensor tendon, close to the base of the dislocated phalanx ; the sharp-pointed tenotome is introduced along the articular surface down the metacarpal, and divides the ligament from before backwards. But open section is always better and surer.

After the ligament has been divided, pull on the thumb and flex it ; reduction is usually effected without any difficulty.

If unsuccessful—and as a matter of fact, in dislocations of some duration, open reduction is far from being so simple as one might be led to believe by certain descriptions—**excise a wedge-shaped portion** of

the median part of the glenoid ligament between the two sesamoid bones; then, while traction is made on the thumb in its long axis, gently introduce an elevator from above down between the two bones; slip the elevator under the head of the metacarpal, and lever it up into position, at the same time flexing the thumb. By this plan I have succeeded in effecting reduction in two old-standing dislocations.

Fig. 235.—Metacarpo-phalangeal dislocation of the thumb forwards.

Lastly, it may happen that complete and permanent reduction is altogether impossible; excision of the head of the metacarpal is then necessary, and with adequate after-treatment will give very good results. I have found it necessary to employ this method on two occasions. In one case the patient was a young woman whose right thumb had been

dislocated in a carriage accident and "reduced" by a cabman. The dislocation was of the complex variety; it was of eight days' standing; it had resisted all attempts, even under chloroform, and section of the glenoid ligament resulted only in incomplete and transitory reduction. I forced the head of the metacarpal forward with the elevator and excised it, trimming up the neck of the bone after the excision with the bone forceps. The wound healed per primam; massage was commenced on the eighth day. Rapid and complete functional restoration was obtained.

Metacarpo-phalangeal Dislocations Forwards (*Fig.* 235).—Just a word regarding these. Have traction applied to the thumb by an assistant; press the dislocated phalangeal extremity backwards with your thumbs, while the fingers resting on the posterior aspect of the articulation pull the head of the metacarpal bone in the opposite direction. In short, **traction and direct pressure**, if possible under general anæsthesia.

VI.—Dislocations of the Fingers.

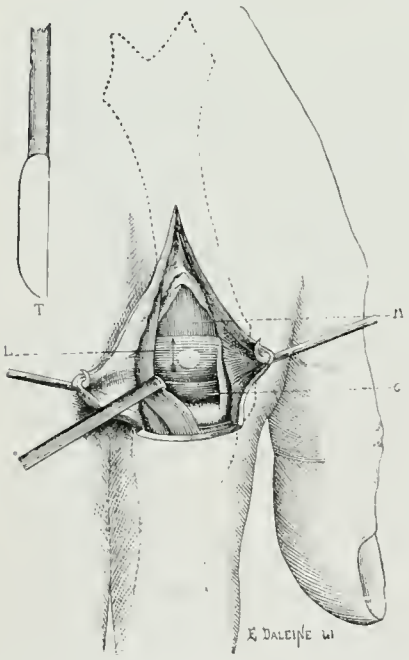

Fig. 236.—Complex dislocation of the right index finger. (Posterior view.) (G) Glenoid cavity of the dislocated phalanx. (L) Glenoid ligament with a sesamoid bone embedded in it. (M) Back of the metacarpal bone. (Jalaguier).

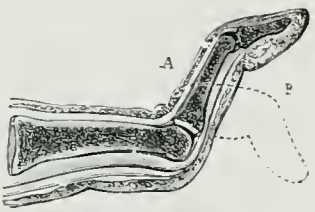

Fig. 237.—Backward dislocation of the second phalanx. (Follin.) (A) Second phalanx turned back on to the metacarpal. (B) Dislocated second phalanx lying parallel to the first.

Fig. 238.—Dislocation forwards of the second phalanx. (Follin.)

Fig. 239.—Dislocation of the terminal phalanx backwards.

The dislocations of the metacarpo-phalangeal articulations of the fingers present the same varieties as the corresponding dislocations of the thumb, and reduction is effected in an exactly similar manner.

Never try direct flexion; whatever the position of the finger, **extend it first and turn it backwards**, and pressing its dislocated extremity against the back of the metacarpal, make it travel back along the way it had come, pushing before it the glenoid ligament.

In the case of a complex dislocation which resists rational manipulations, perform open section or subcutaneous division of the glenoid ligament (*Fig.* 236).

" The surgeon, holding the tenotome like a pen, makes a puncture in the skin, half an inch behind the base of the phalanx and immediately to the outer side of the extensor tendon. The handle of the instrument is held sloped along the back of the hand, parallel to the tendon, and the point is insinuated under the skin towards the articular surface of the phalanx. The point soon meets the articular surface and recognizes it. The handle

Fig. 240.—Reduction of a dorsal dislocation of the terminal phalanx of the index finger.

must then be raised so as to depress the point, which, without losing touch with the articular surface of the phalanx, is directed against the palmar ligament lying on the dorsal surface of the metacarpal. All that remains to be done is to divide the ligament, which is easily effected by pressing the point of the knife firmly against the dorsal surface of the metacarpal and drawing it backwards for about a third of an inch " (Jalaguier).

With regard to **dislocations of the phalanges** (*Figs.* 237, 238, and 239), they can usually be reduced without trouble by a combination of traction and direct pressure.

Fig. 240 shows the position of the hands and the method to be followed. While an assistant pulls on the finger, the operator grasps the phalanx, thumbs above and index fingers crossed below, and applies direct pressure on the dislocated extremities.

VII.—Dislocations of the Hip.

EXAMINATION.

Traumatic dislocation of the hip is an uncommon injury: *in four cases out of five the femoral head is displaced backwards*, and of the backward dislocations the *iliac variety* is the one which is most often met with.

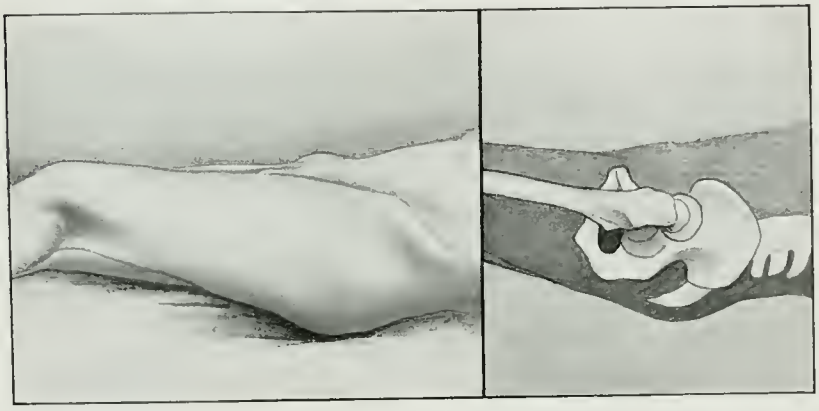

Fig. 241.—Iliac dislocation of the hip.

Dislocations Backwards, Iliac.—(*Fig.* 241).—The thigh is adducted and rotated inwards, and is fixed; the deformity may be exaggerated a

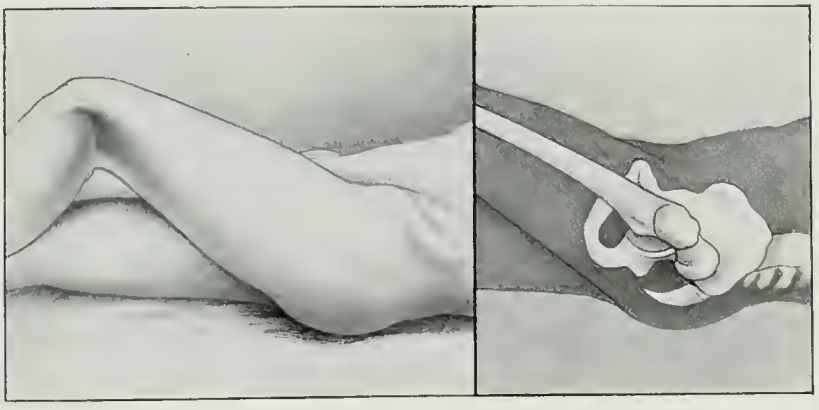

Fig. 242.—Sciatic dislocation of the hip.

little, but no abduction or external rotation is possible. There is but little flexion, and the limb appears shortened.

Look for the great trochanter; it projects prominently outwards, and lies markedly above the Nélaton-Roser line.

If the patient is thin or anæsthetized, the head of the femur can be felt on the dorsum ilii under the gluteal muscles.

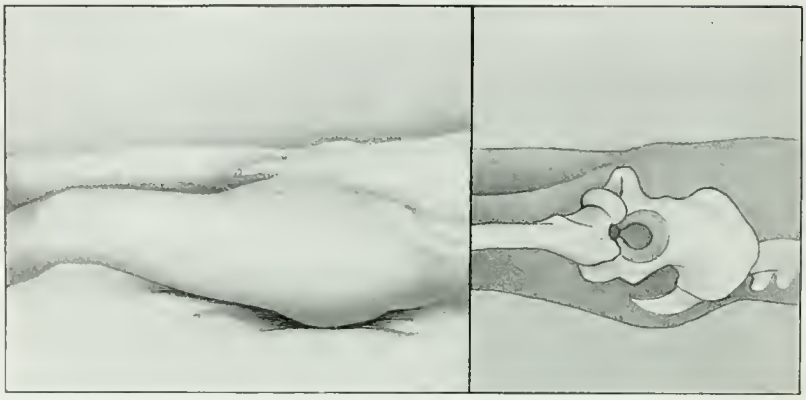

Fig. 243.—Obturator dislocation of the hip.

Dislocation Backwards, Sciatic (*Fig.* 242).—The thigh is fixed in a position of adduction and internal rotation. Flexion is very marked, sometimes to a right angle or even to an acute angle, and the thigh is also fixed. The head can be felt low down in the hip at the position of the sciatic notch.

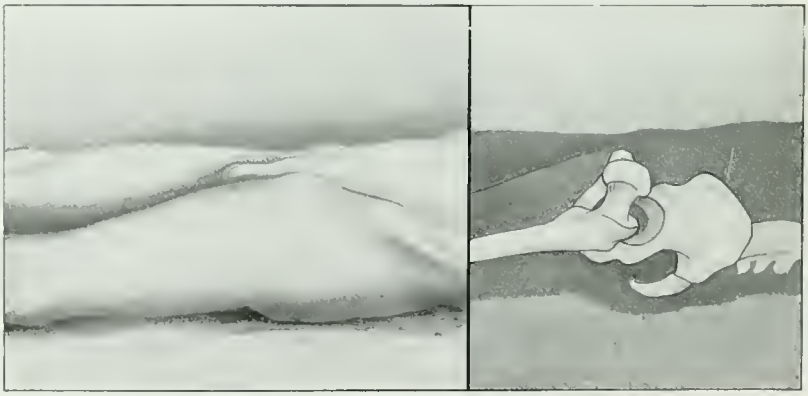

Fig. 244.—Suprapubic dislocation of the hip.

Dislocation Forwards, Obturator (*Fig.* 243).—The thigh is strongly abducted, rotated outwards and fixed, and also moderately flexed.

The head lies over the obturator foramen, behind the femoral vessels, which it pushes forwards, and it is more or less accessible to palpation.

With a little more flexion and abduction, the head lies in the perineum, and the dislocation is termed **perineal.**

Dislocation Forwards, Suprapubic (*Fig.* 244).—The thigh is fixed, abducted, and rotated outwards; it is extended, or only very slightly flexed.

The great trochanter can no longer be felt. The femoral head forms a prominent boss in the groin, and pushes the great vessels forward.

Amongst the very rare forms, the **subcotyloid,** directly downwards, should be mentioned; the thigh is in extreme flexion without any rotation or inclination to one side or the other; the head rests on the tuberosity of the ischium.

When the capsular lacerations are very extensive, or during attempts to effect reduction, one type of dislocation may be converted into another, the head of the femur moving around the acetabulum without entering it, an iliac dislocation, for instance, may be transformed into the obturator variety.

REDUCTION.

Remember that here, as in other regions, reduction is not a matter of force. A general anæsthetic is indispensable.

ILIAC DISLOCATION.

Have the patient laid on the floor on a hard mattress; place yourself in front and a little to the side of the dislocated limb. A strong assistant applies his hands widely over the iliac spines, and rests his weight on the pelvis, so fixing and immobilizing it.

1st step.—**Progressive Flexion of the Thigh.**—With one hand grasp the thigh firmly above the knee; with the other take the leg and begin to raise the limb steadily, bending it at the hip and knee (*Figs.* 245 and 246).

2nd step.—**Vertical Traction on the Flexed Thigh.**—Flex the thigh to a right angle; then only begin the traction. The traction on the flexed limb must be made in a direction vertically upwards; the thigh is pulled directly towards the surgeon as if to separate it from the pelvis (*Fig.* 247).

At this stage—and in the direction just indicated—a considerable degree of force must be exerted, while keeping the thigh carefully flexed at a right angle.

This step must be looked upon as the most important one; if it is properly carried out, with the thigh quite vertical, a sudden jerk will often indicate that reduction has taken place, before even the third step has been begun.

Fig. 245.—Reduction of an iliac dislocation of the hip.
1st step: The pelvis is fixed; the thigh is steadily raised.

Fig. 246.—Reduction of an iliac dislocation of the hip.
Continuation of the first step: The thigh is increasingly flexed.

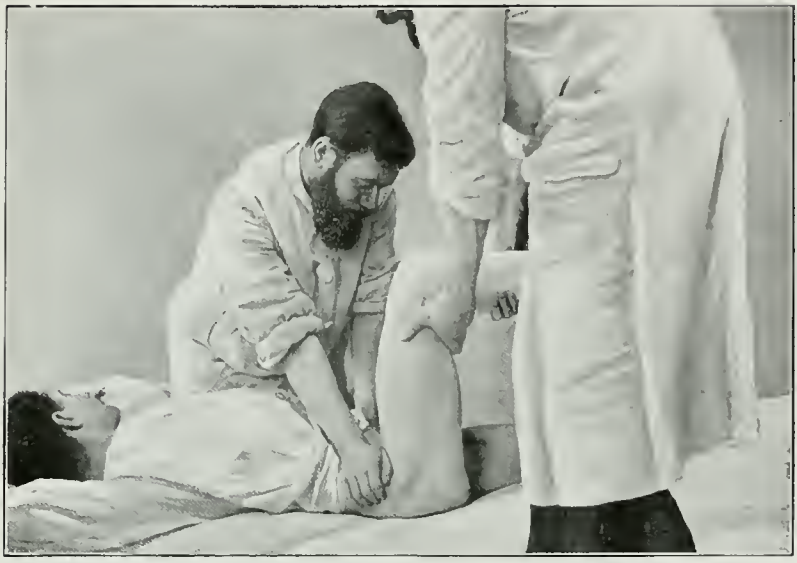

Fig. 247.—Reduction of an iliac dislocation of the hip.
2nd step: Vertical traction on the thigh flexed to a right angle.

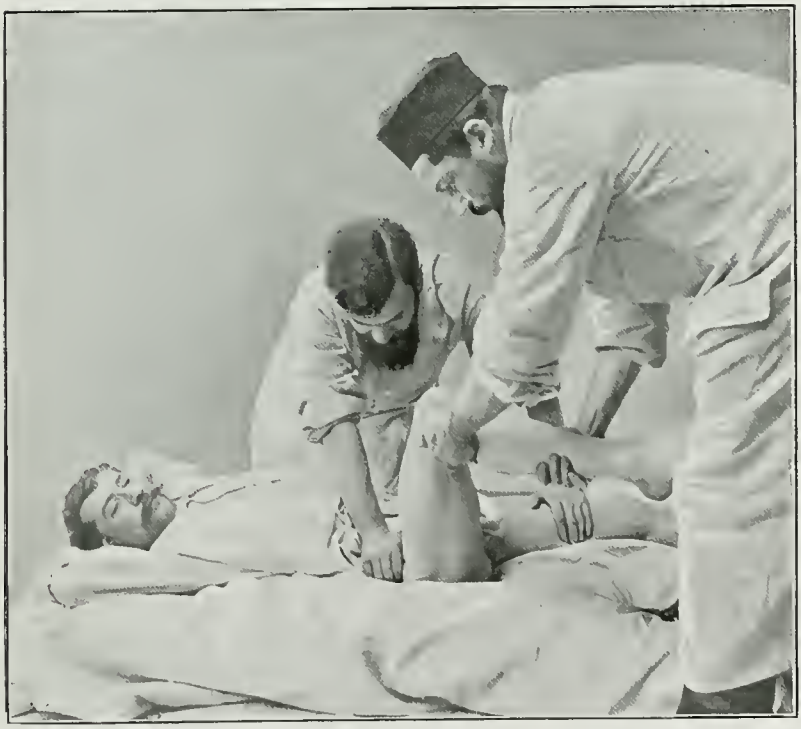

Fig. 248.—Reduction of an iliac dislocation of the hip. 3rd step: Rotation of the thigh outwards.

3rd step.—**Abduction and Rotation Outwards.**—Soon it will be felt that something is yielding; then combine outward rotation of the thigh with the vertical traction (*Fig.* 248), and the femoral head, rolling under the acetabulum, will suddenly enter the cavity. I have on several occasions reduced recent traumatic posterior dislocations of the hip, and I have always been struck with the ease and rapidity with which reduction has been effected when the vertical traction has been exerted in the proper direction.

If traction is applied with the thigh incompletely flexed, great efforts may be made and much force employed, but no good results will follow; but if one bends up a little more, to a right angle or perhaps even a bit beyond it, suddenly, in a certain direction, always very near the vertical, reduction will take place.

This method, which was originally employed by Desprès père and afterwards systematized by Bigelow, is as a rule the only one which ought to be used.[1] The methods which follow are merely variations of it.

(*A*). **Method of Reduction with the Shoulder.**—Place the patient on a low, firm table, with the pelvis projecting a little over the edge; one assistant supports and abducts the sound limb, while another fixes the iliac spines.

The right shoulder is usually the best to use; the surgeon stands therefore between the patient's legs if it is a case of dislocation of the right hip; to the outer side of the limb in dealing with a dislocation of the left hip.

1st step.—Bend down and take the knee over the shoulder, arrange it conveniently, and secure it with the right hand, while the left hand grasps the lower part of the leg (*Fig.* 249).

2nd step.—Rise slowly, keeping the limb slightly abducted; when the upright position is reached, the thigh will be vertical, and flexed at a right angle on the pelvis, and with a sharp movement of the shoulder it will be easy to increase the upward traction and to disengage the head of the femur (*Fig.* 250).

(*B*). **Method of Reduction with a Folded Sheet** (Le Fort).—Have the patient laid on the floor; roll up a sheet and pass it transversely under the knee; then raise the thigh vertically and have it held in that position by the sub-popliteal sheet, the two ends of which are held and vigorously pulled upon by the assistants, the pelvis being, as before, securely fixed.

[1] M. Delanglade has on two occasions practised reduction *in ventral decubitus*; the patient is placed face downwards on a table with the thighs projecting over the edge; the surgeon flexes the dislocated thigh, and applying his knee to the popliteal space, he pushes it downwards; while with one hand he holds and manages the leg, with the other he acts directly on the femoral head. In this position, counter-extension is better assured, and the operator's efforts, being exerted in the form of pressure from above downwards, are easier, and it may be possible to dispense with anæsthesia. (Delanglade, "Luxations traumatiques de la hanche; manœuvres de rêduction dans le decubitus ventral," *Marseille médical*, 1 août, 1904).

Then take the leg, which is hanging free, and apply strong pressure downwards and backwards on its lower third (*Fig.* 251); the sheet serves as a point of support, as a fulcrum for the force employed, which is transmitted to the thigh in a good direction and tends to raise it and to disengage the head of the bone.

The leg is used as a lever, and the power exerted is therefore employed

Fig. 249.—Iliac dislocation of the hip. Reduction by the shoulder method. 1st step: The operator takes the knee over his shoulder.

at a considerable mechanical advantage. The necessary condition, however, and also the difficult condition, for the satisfactory employment of this method, is that the supporting sheet shall be kept perfectly steady.

(*C*). **Method of Reduction with a Pulley to the Roof.**—In some particularly difficult cases, and when the accident is of several days'

standing, it may be useful to employ more powerful and more prolonged traction or elastic traction.

But in iliac dislocation, traction in the longitudinal axis of the limb must on no account be employed ; the pull must be upwards towards the ceiling, and practically the method of applying it is as follows.

Fig. 250.—Iliac dislocation of the hip. Reduction by the shoulder method. 2nd step : The operator rises, so elevating the dislocated limb.

To the lower third of the thigh, above the condyles, attach a traction loop, arranged as in *Fig.* 253 ; to it the cord, rubber bandage, or rubber tube will be fixed. Sometimes a fixed point in the roof will be found without much trouble, or it may be improvised with a ring or hook ; if need be, the top of a door or a well-secured ladder will serve. For this purpose Bigelow had a tripod bearing a pulley at its upper part constructed.

Fig. 251.—Iliac dislocation. Reduction by means of a folded sheet.

Fig. 252.—Preliminary circumduction before reduction of a dislocation of the hip of some days' standing.

After the traction cord is carried over the upper fixed point, by pulling on its descending end, plenty of power can be exercised to lift the head of the femur if the pelvis is properly fixed. A set of pulleys will be even more useful. Lastly, elastic traction acting in the same vertical direction may also be employed, with all the advantages which we have ascribed to the method elsewhere.

In those dislocations which are not quite recent, it will often be well, before starting the vertical traction, to overcome rigidity by some movements of adduction, abduction, and rotation inwards and outwards (*Fig.* 252).

SCIATIC DISLOCATIONS.

The method of reduction is the same as before, and comprises the three following steps: (1) The patient being laid on a mattress on the floor, flex the thigh to a right angle, keeping it in the vertical antero-posterior plane; (2) Make traction on the thigh, **directly upwards**; (3) While continuing

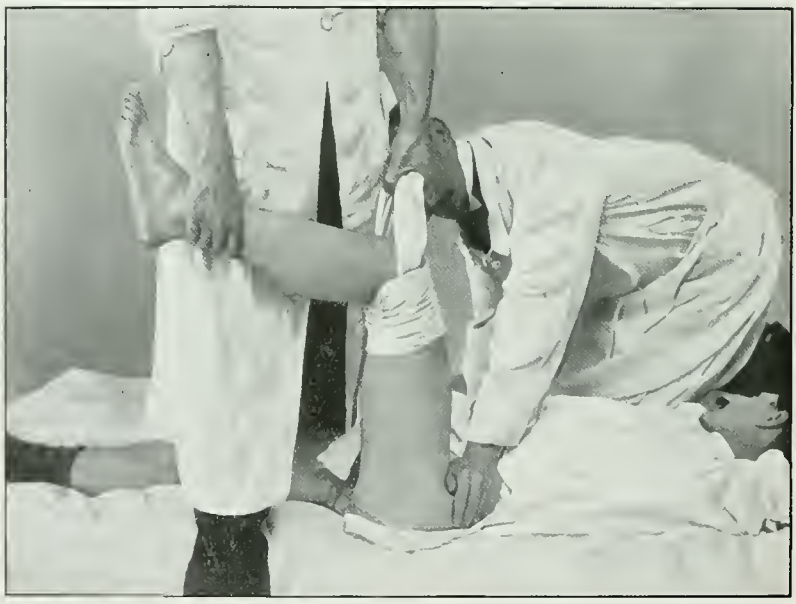

Fig. 253.—Sciatic dislocation. Vertical traction.

the upward traction, carry the limb into a position of abduction and external rotation. Usually, at the end of the second or the beginning of the third step, a sudden crackling indicates that the head of the femur has re-entered the acetabulum.

If the limb is abducted too soon, the probable result will simply be

a change in the character of the dislocation ; the head of the femur rolls under the margin of the acetabulum without entering the cavity, and lodges in the obturator region : *the sciatic dislocation is transformed into an obturator dislocation.* The limb, which had previously been in a position of adduction and internal rotation, becomes markedly abducted and rotated outwards ; it is then necessary to employ the manœuvre which we shall describe immediately ; but in some dislocations complicated by extensive laceration of the joint-capsule it happens that the transformation is repeated in the opposite direction, and the head continues to roll to and fro below the margin of the acetabulum without being able to enter the cavity ; in such a case, the head can be made to jump over the rim of the acetabulum by direct vertical traction at a right angle (*Fig.* 253) combined with a sudden forcible jerk ; the shoulder method (*Fig.* 249, 250) is particularly useful in these circumstances.

DISLOCATIONS FORWARDS.

Obturator Dislocation.—Here again, traction " in flexion " is the least harmful and most rational mode of reduction.

Fig. 254.—Obturator dislocation. Traction outwards.

First, flex the thigh gradually until it becomes perpendicular to the plane of the trunk and pelvis, the pelvis being fixed by an assistant ; while

raising the limb, bring it into the vertical antero-posterior plane of the body (*Fig.* 256); then pull strongly upwards on the flexed thigh, at the same time pressing the knee inwards and carrying the leg outwards, to obtain adduction and internal rotation of the thigh (*Fig.* 257). In short, **flexion, elevation,** and **adduction** are the three steps in the process of reduction, and the last two must be combined.

There is another method which may be found useful. Counter-extension is provided by means of a folded sheet passed obliquely under the perineum. Powerful traction is exerted by the combined efforts of several assistants in the axis of the dislocated limb—that is to say, in extreme abduction—while the surgeon endeavours to pull the femoral head

Fig. 255.—Iliopubic dislocation. 1st step: Abduction.

directly outwards by traction on a folded towel placed around the supero-internal part of the thigh. Or again, the following manœuvre may be employed: a folded towel is placed under the upper part of the thigh, and the ends knotted together behind the neck of the operator, who, stooping down, pushes the knee and thigh inwards with the hands, and at the same time forces his neck backwards, and so drags with all his strength on the towel (*Fig.* 254).

Outward traction on the upper part of the thigh may also be employed with a sudden jerk, as recommended by M. Riedel. The anæsthetized patient is placed at the edge of the table, and counter-extension provided; two assistants make traction on the dislocated limb, in moderate flexion

and abduction ; at the moment when their effort is at its maximum, the surgeon passes his right arm, if dealing with the left thigh (or his left if dealing with the right thigh), below and internal to the upper part of the patient's thigh, raises it a little, and then, with a sudden movement, pulls it outwards, while with the other hand he presses the knee strongly inwards.[1]

Iliopubic Dislocation.—In these cases it appears to us to be irrational to try to effect reduction by means of traction in the axis of the limb, particularly as a very great force must be exerted to produce any movement of the head of the femur ; flexion is also quite useless, and

Fig. 256.—Iliopubic dislocation. 2nd step : Steady flexion.

besides, it is only possible to a very limited extent, at least without incurring the risk of forcing the upper end of the femur into the pelvis.

Forced abduction must be the first step ; the manœuvre will be carried out in the following manner : Take hold of the thigh, raise it a little, and carry it outwards ; abduct it as far as possible ; as the degree of abduction increases, the limb will allow itself to be raised still further : the head slips downwards, and finally the iliopubic dislocation is converted into an obturator one—that is *the first step* (*Fig.* 255).

[1] Riedel, "Die Reposition der Luxatio obturatoria durch Ruck nach aussen" (*Deutsche Zeitschrift fur Chirurgie*, 1905, lxxix., 4–6, p. 331). M. Riedel in this way has reduced two old-standing dislocations (after incision) and three recent dislocations.

Then **flex the thigh**, approaching it gradually to the vertical, and **pull it directly upwards**—*2nd step* (*Fig.* 256); **adduct it and rotate it inwards** — that is *the 3rd and last step*. In fact, the iliopubic dislocation is converted into an obturator, and the obturator dislocation is reduced by the usual method.

In this way I have succeeded in reducing an iliopubic dislocation of three days' standing, which had resisted numerous—and I may add, skilled —attempts to effect reduction. Everything had failed; but at last by forced abduction we succeeded in dislodging the femoral head into the foramen ovale, and then reduction was obtained without difficulty.

Fig. 257.—Iliopubic dislocation. 3rd step: Adduction and internal rotation.

It is advisable to mention the dislocations complicated by fractures of the acetabulum or femur, and to recall the possibility of the femur being broken during the course of violent reductory manipulations. In such cases primary reduction should not be attempted; continuous extension will be applied, and union of the fracture awaited, before dealing with the dislocation.

Attempts at secondary reduction will, however, involve considerable risk of re-fracture unless a very long time is allowed to elapse; and on the other hand, the prolonged delay will make the ultimate result very uncertain; therefore, it is very much better, if the patient's age and general condition justify it, to have recourse at once to open methods.

In the case of a recent dislocation, if methodical attempts at reduction under chloroform have failed, keep the patient at absolute rest for two or

three days, applying continuous extension to the limb if it can be tolerated ; then make a second attempt, trying the various different methods and carefully and completely observing the different steps.

If failure again results, then it is necessary to prepare for dealing with the condition by open methods.

Operation undertaken in good time will give the best chances of being able to effect complete reduction, and will give very good functional results, particularly in young patients ; at later stages, resection of the dislocated head will probably be required, or perhaps a subtrochanteric osteotomy.

VIII.—Dislocations of the Patella.

These dislocations almost always take place in the **outward** direction, and belong to one or other of the three following types : (1) **The patella rests on the outer aspect of the external condyle** ; it has become antero-posterior, with its internal border directed forwards and pushing up the skin to the outer side of the external margin of the femoral articular surface (*Fig.* 258). This variety is the commonest (or one might put it, the least uncommon) ; (2) **The patella is dislocated outwards, but**

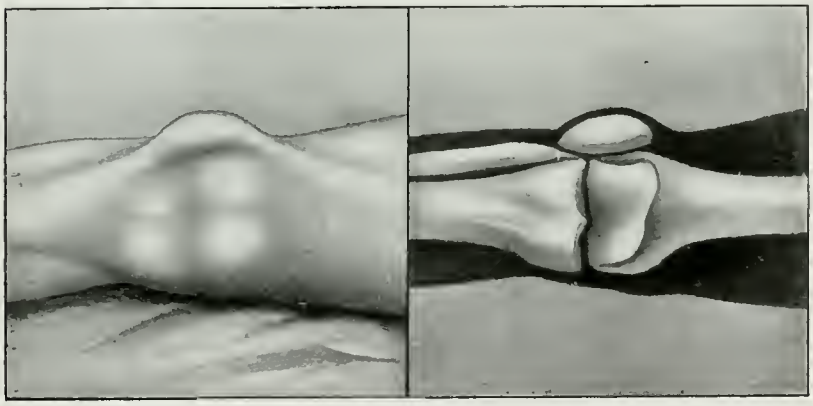

Fig. 258.—Dislocation of the patella outwards.

is not rotated ; it remains transverse, but is in contact with the external condyle of the femur by its inner border only ; it projects outwards from the articular margin of the external condyle like the leaf of a folding table ; (3) **The patella is twisted around its vertical axis, but remains in contact with the front of the femur** ; its internal border has become posterior, and rests in the intercondyloid notch ; its outer border projects prominently under the skin over the front of the knee. I do not need to enter into a description of the very rare forms, such

as *complete inversion from above downwards*, nor yet of the partial dislocations.[1]

The difficulties associated with reduction vary widely, not only according to the nature of the displacement, but also according to the condition of the musculature and the fibrous tissues.

I have seen a vertical external dislocation (1st variety) which was most easily reduced; it had occurred only a few hours previously, and the deformity was very characteristic; the increase in the transverse diameter of the knee, the prominence of the two sloping articular surfaces of the femur under the skin, the curvature outwards of the patellar tendon and ligament, which formed two tense cords, the patella applied immovably

Fig. 259.—Reduction of an external lateral dislocation of the patella.

to the external condyle, all contributed to give the knee—which besides was very thin—a quite typical appearance.

I had the patient's foot raised by an assistant in the way I shall describe in a moment, and by pressure exercised from behind forwards on the outer border (which had become posterior) of the patella, speedily succeeded in causing the displaced bone suddenly to slip forwards into its proper position.

In dealing with any form of dislocation of the patella, the line of treatment ought to be as follows (*Fig.* 250).

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[1] See L. Chevrier, *Des luxations de la rotule.* Thèse de Paris, 1904.

Keeping the knee quite straight, **raise the heel and flex the thigh to a right angle**; in this position of the limb the maximum degree of relaxation of the quadriceps is obtained, and if the patient "lets himself go properly" there will no longer be any muscular obstacle to reduction.

The surgeon next devotes his attention to disengaging the patella and restoring it to position; to do so, he grasps the front of the knee with the two outspread hands, and applying both thumbs to the posterior border of the dislocated patella (if dealing with a vertical external dislocation), **pushes it, first from behind forwards, then from without inwards.**

In the case of a transverse dislocation without rotation, try to get the thumbs as far as possible underneath the patella, in order to **raise it en masse over the prominent ridge which bounds the external condyle.**

When dealing with a dislocation by torsion, the first thing to be done is carefully to determine how the surfaces are presenting, so that pressure may be applied to the superficial surface, to make it rotate in the proper direction.

Of course, general anæsthesia is useful in all the more complex varieties, and when direct pressure proves insufficient, other methods must be tried; for instance, the thigh being kept horizontal, the knee may be steadily flexed to the extreme limit possible, and again, the flexion may be followed by sudden extension; when suddenly displaced in this manner the patella will sometimes become movable.

If these various procedures, all of which do not lend themselves to didactic description, have failed after due trial with the assistance of general anæsthesia, the best plan will be to effect reduction by open methods, not by means of elevators insinuated through small openings in the skin, but by free incision, sufficiently large to provide adequate access to the patella.

IX.—Dislocations of the Knee.

The knee may be dislocated *forwards*—the least uncommon form—*backwards*, *outwards*, or *inwards*; and all these dislocations are rendered particularly serious by the **frequency of vascular lesions** and ruptures of the skin and the other peri-articular tissues.

These complications apart, dislocations of the knee do not usually present any great difficulties in the way of reduction. **Traction on the leg in extension**, combined with **direct pressure in opposite directions on the two articular extremities**, femoral and tibial, summarize the methods to be employed.

Dislocation Forwards.—There is considerable deformity of the knee; in front there is a large prominence, over which the skin is stretched, and which can usually be recognized without much difficulty as the upper

extremity of the tibia ;[1] above it another prominence is seen, the patella sloping obliquely backwards to the femur. Posteriorly the popliteal hollow has disappeared, and its place is occupied by the large mass of the femoral condyles, the internal condyle in particular showing itself immediately under the skin.

Looked at from the front, the thigh appears unduly short and the leg of normal length ; as a whole the limb is really *shortened.* Very definite lateral movement is present at the knee. Almost invariably, the foot and leg are discoloured, cold, and insensitive to a variable degree, even when no irremediable complications exist and the vessels are simply compressed. Immediate reduction is none the less urgently necessary.

General anæsthesia is advisable in every case. Counter-extension is provided by an assistant, who grasps the upper part of the thigh with both his hands ; another assistant takes hold of the lower third of the leg and makes steady traction in the axis of the limb, without carrying it backwards or forwards and without inclining it to the right or to the left ; the surgeon himself applies his fingers as widely as possible over the popliteal space, over the prominence formed by the femoral condyles, and pulls upwards and forwards " towards himself," while his thumbs pressing against the upper end of the tibia push it downwards and backwards.

Sometimes it will be found better to apply the whole of one hand over the femoral condyles behind, and the other in front over the head of the tibia, and to push and pull in opposite directions.

Lastly, in difficult cases it will be useful to employ the following manœuvre : the operator places himself outside and behind the dislocated joint, a folded towel is passed under the backwardly projecting femoral condyles, with the ends knotted together over the back of his neck ; in this manner it is possible to exert powerful traction by the nuchal muscles **to raise the condyles,** while both hands remain free to **push the head of the tibia downwards and backwards.**

Dislocations Backwards (*Figs.* 260, 261).—The methods of reduction are analogous to those just described. It must not be forgotten how very dangerous reduction may be, when the artery is stretched ready to rupture over the posterior border of the upper end of the tibia : *the slightest tilting backwards of the upper end of the tibia may involve an arterial laceration.*

The extension must therefore be applied on the lower third of the leg, in the axis of the limb, without elevating the foot, while endeavouring at the same time progressively to flex the knee until the upper extremity of the leg slips down from behind the condyles.

With regard to **lateral dislocations** outwards or inwards, they are often incomplete, and as a rule yield without much difficulty to extension and direct pressure.

[1] The form of dislocation is named according to the position of the tibia.

It is therefore not the difficulties accompanying reduction which produce the grave prognosis always associated with these dislocations, but the frequency of **injuries to vessels and nerves** (it is usually the external popliteal nerve that is stretched and bruised) and **cutaneous lacerations** (compound dislocations).

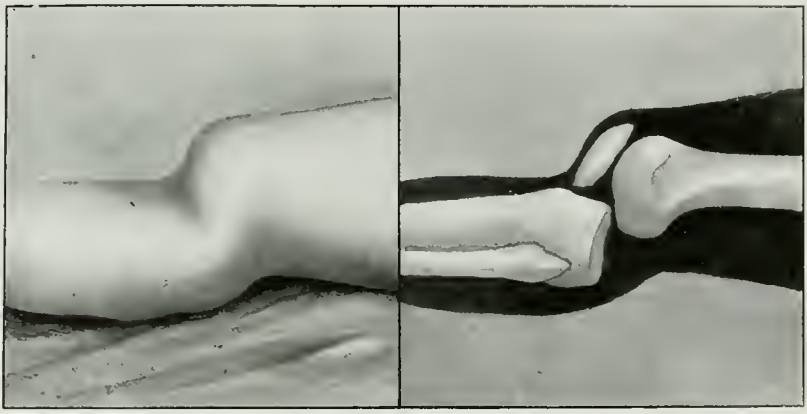

Fig. 260.—Incomplete dislocation of the tibia backwards.

As a matter of fact two possible conditions may arise.

1. **There is no external wound**; but the popliteal space is occupied by a huge accumulation of blood; the limb is cold and insensitive, the pulsations of the posterior tibial and dorsalis pedis cannot be felt; in fact, all the signs of **rupture of the popliteal artery** are present.

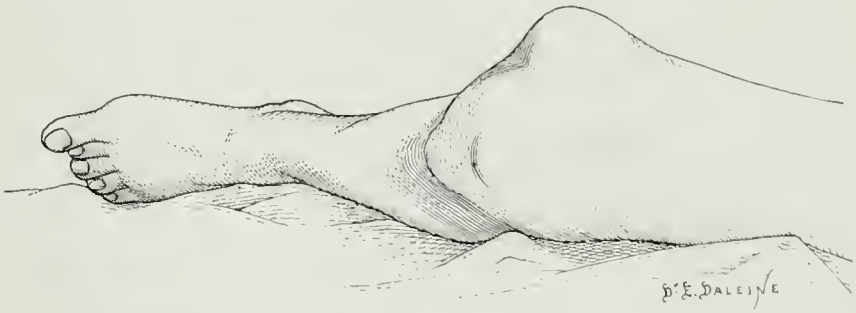

Fig. 261.—Dislocation of the knee backwards.

First reduce the dislocation under chloroform; then, if the appearance of the limb does not improve, apply an Esmarch's bandage to the thigh, and, after having thoroughly prepared the whole region, open the popliteal space by a free incision, clear it of blood and clots, examine the large vessels carefully, tie the divided or crushed ends, remove the hæmostatic

band from around the thigh, and after making sure that all bleeding has ceased, close the wound.

This bold open operation is certainly much better than any expectant and delayed measures ; nothing is lost by tying the two ends of the ruptured popliteal artery, and much may be gained by opening up the area and evacuating the extravasated blood, so relieving the collateral vessels from pressure and restoring their permeability, if it is not already too late.

But it may be, that though all the signs of complete obstruction of the great vessel are present, there is no extensive extravasation of blood and no popliteal swelling. In such circumstances, after reduction has been effected, there is no further immediate indication to be met ; envelope the limb in a thick layer of wool, have it slightly elevated, and apply gentle warmth : this is all that can be done—and it is very little—while waiting to see whether gangrene develops or the limb recovers its vitality. (See Ruptures of the Large Vessels.)

2. **The dislocation is compound.** The skin is extensively torn transversely in the popliteal space, and the wound communicates with the focus of dislocation.

It is always advisable, after careful disinfection of the wound and the surrounding area, **to reduce the dislocation under chloroform.**

As soon as the articular extremities are in place, if the limb retains or recovers some warmth, and if the pulsations of the posterior tibial artery can be felt behind the internal malleolus, then, whatever the local lesion may be, an attempt must be made to save the limb, and the steps necessary to attain that object must be taken. (See Crushing Injuries.)

Even when the vitality of the foot and leg seems very doubtful, it is advisable to wait until gangrene is absolutely certain, before sacrificing the limb ; this extreme conservative course will be free from danger if the case is seen at once, and if it is possible thoroughly to cleanse the damaged area in good time.

In the opposite conditions, when there is complete rupture of the popliteal vessels, when the limb is pale, cold, and devoid of sensation, when the wound is soiled and infected, then immediate amputation is the correct line of treatment. (See Crushing Injuries.)

X. Dislocations of the Foot.

The complex traumatisms—and in particular the dislocations—of the foot create very considerable diagnostic difficulties ; imperfectly recognized, they are often incompletely reduced, and in consequence leave in their train persistent deformities and grave disabilities. Therefore it is very necessary, in the first place, to have a very clear idea of the various forms which may be met with, and their relative frequency ; and secondly, to follow a definite method of examination. Amongst the dislocations of the foot, the following groups must be distinguished :—

1. *The tibio-tarsal dislocations*, denominated **according to the direction of displacement of the foot.**

The whole foot is displaced on the leg—**outwards, inwards, forwards,** or **backwards**—and the accident seldom occurs, especially in the lateral varieties, without fractures of the malleoli.

2. *The sub-astragaloid dislocations* ; the leg and the astragalus retain their normal relationships, the tibio-tarsal articulation is intact ; **it is the rest of the foot which is displaced under the astragalus,** and as before, the dislocation may be **outwards, inwards, forwards,** or **backwards.**

3. *The isolated dislocations of the astragalus,* which is separated both from its **tibio-fibular** and also from its lower **calcaneo-cuboid connections,** and is carried forwards or backwards or perhaps undergoes various complex displacements, placed **transversely** across the front of the foot, turned around its antero-posterior axis **on to its side,** so that its upper surface looks inwards or outwards, or even **turned completely over from above downwards.**

Farther on we shall say a few words with regard to the **medio-tarsal** and **tarso-metatarsal dislocations** and the **dislocations of the toes.**

One important point must first of all be recalled : unlike the deformities associated with fractures, those which result from dislocations are fixed, and yield only to the forcible manipulations which we shall study later on.

With this point in mind—and without depending too much on appearances, which are often very deceptive owing to the swelling—proceed to make a careful, methodical examination.

Inspect the foot, its tip, the sole and its borders, after first straightening the leg and placing it flat on its posterior surface.

Feel for the malleoli, by following the lateral surfaces of the tibia and fibula from above downwards ; compare with the sound foot, and note the distance which separates each from the prominence of the heel and from the corresponding border of the sole.

Examine the region of the tendo Achillis, and if possible make the patient stand upright (supported if necessary), or better, make him kneel at the edge of the table and inspect the foot from behind, from the heel.

Examine the dorsal surface of the foot ; prolong the crest of the tibia along the dorsum of the foot ; normally it ought to end at the second toe (Tillaux) ; note, therefore, where it ends on the injured foot.

Then only try to recognize by palpation any abnormal prominence which is found on one side or the other, and remember that palpation is often at fault, and that the fact, duly established, of a definite and fixed deviation of the foot in this or that direction is a certain sign of dislocation.

Such deviation—*en masse*—may present itself : **in the antero-posterior direction,** or **in the lateral direction.**

1. ANTERO-POSTERIOR DISLOCATIONS.

A. **Dislocation Backwards.** — The foot presents the appearance depicted in *Fig.* 262 ; a transverse ridge shows itself above the instep ;

the tendo Achillis region is markedly hollowed, and the heel projects prominently backwards.

What conditions might produce these appearances? A supra-malleolar fracture with falling of the heel—a bi-malleolar fracture with subluxation of the foot backwards — a tibio-tarsal or sub-astragaloid dislocation backwards.

The two malleoli are much farther from the point of the heel than on the opposite foot; the dorsum of the foot is shortened; the anterior prominence is not abrupt and sharp-edged, like the margin of a fractured surface, and corresponds to, or lies a little below, the line of the tibio-tarsal articulation; the attitude of the foot is fixed: it may be concluded that there is a dislocation backwards.

Is it tibio-tarsal or sub-astragaloid? The examination of the anterior prominence will be the best guide to the correct diagnosis: in a case of

Fig. 262.—Tibio-tarsal dislocation backwards.

tibio-tarsal displacement (*Figs.* 263, 264) the anterior margin of the tibio-fibular notch can be recognized by palpation, and below it there is a hollow, more or less appreciable according to the degree of tension of the extensor tendons and the amount of swelling. When there is a **sub-astragaloid dislocation**, the anterior prominence is more elongated, more convex; it descends on to the foot below the line of the tibio-tarsal articulation, and on it the projecting and exposed head of the astragalus can be recognized.

Further, the shortening of the front of the foot is greater in the case of the sub-astragaloid dislocation.

Reduction.—The patient is laid on a table, with the foot projecting over the end and the lower part of the leg securely fixed by an assistant. The surgeon stands in front of the dislocated foot, grasps the heel with one hand and the metatarsal region with the other; *he pulls towards*

himself first of all, then *carries the foot strongly forwards, at the same time gradually flexing it.*

Fig. 263.—Tibio-tarsal dislocation backwards.

Fig. 264.—Tibio-tarsal dislocation backwards.

In the sub-astragaloid dislocations backwards—in other words, when the head of the astragalus shows itself prominently on the dorsum of the

foot—it will be necessary, as Quénu has shown,[1] to *dorsiflex the foot* strongly to effect reduction, and the following manœuvre may be employed with advantage: the patient's knee being kept flexed, the sole of his foot is rested broadly against the chest of the surgeon, who, with his two hands disposed as above, *pulls on the heel from behind forwards, and presses on the head of the astragalus from before backwards.*

B. **Dislocations Forwards.**—These are quite uncommon (*Fig.* 265). The malleoli are approximated to the tendo Achillis; the axis of the leg is carried backwards. The posterior aspect of the ankle is flattened or convex; the dorsum of the foot is considerably elongated, and at its posterior part the exposed body of the astragalus can be recognized.

Very similar signs are present in **a forward sub-astragaloid dislocation:** the dorsum of the foot is elongated, flattened, and hollowed

Fig. 265.—Tibio-tarsal dislocation forwards.

posteriorly; the prominence of the heel has disappeared, but above the os calcis, the tendo Achillis is pushed backwards by the astragalus and the bones of the leg.

Reduction.—By much the same procedure as before, with one hand grasp the lower part of the leg, with the other the mid part of the foot, and while pulling the leg bones forward, push the foot backwards.

Here, again, it will be useful to have the leg flexed.

2. LATERAL DISLOCATIONS.

A. **Dislocation Inwards.**—Examine *Figs.* 266 and 267; they represent a **sub-astragaloid dislocation inwards.** The entire foot is displaced

[1] Quénu. *Soc. de chir.*, 16 mai, 1894.

inwards and inverted; the axis of the leg falls to the outer side of the external border of the sole.

The external malleolus projects prominently under (and sometimes perforates) the skin; farther down, the exposed head of the astragalus can be felt on the posterior part of the dorsum of the foot.

In the case of a **tibio-tarsal dislocation** the foot is displaced *en masse* to the inner side; in front the anterior border of the empty tibio-fibular notch projects under the tendons and integuments of the front of the ankle; the internal malleolus, often both malleoli, are fractured; almost invariably the skin is ruptured, either to the inner or outer side of the ankle. It is a rare injury, but a very serious one.

Fig. 266.—Sub-astragaloid dislocation inwards.

Fig. 267.—Sub-astragaloid dislocation inwards.

Reduction.—Stand in front and to the outer side of the foot, and have the knee flexed; with one hand grasp the front of the ankle, and with the other take firm hold of the sole and the calcaneal region, and pull the foot downwards and outwards; do not begin by trying to raise the outer border of the foot, but pull, first of all, on the posterior part of the foot from above downwards and from within outwards, to overcome the internal displacement, and only after that has begun to yield, begin the everting movement.

It is a good plan, while the fingers of the "plantar" hand are pulling down the inner border of the dislocated foot, for the thumb of the other hand, broadly applied over the prominence of the external malleolus or on the head of the astragalus, to make pressure in the opposite direction.

B. **Dislocation Outwards.**—The axis of the leg (or of the crest of the tibia) falls to the inner side of the internal border of the foot ; the foot is displaced outwards and is in a position of extreme eversion.

A large prominence shows itself on the inner side ; it is formed by the tibia and the astragalus, and the displaced head of the latter distends the skin.

In the case of the much rarer **tibio-tarsal dislocation,** only the prominent internal malleolus and the empty tibial articular surface are to be felt on the inner side. The malleoli are fractured and the skin is very often torn.

Reduction.—The patient is placed as before ; the operator stands a little to the inner side, takes the ankle in one hand, the back part of the dislocated foot with the other, and pulls towards himself, first downwards, then gradually inverting the foot.

3. ISOLATED DISLOCATIONS OF THE ASTRAGALUS.

Those which have most frequently been observed are the dislocations forwards, that is to say, forwards and inwards or forwards and outwards ; it is doubtful if a dislocation directly forwards ever occurs.

A. **Dislocations Forwards and Inwards.**—The foot is everted, in a position of extreme valgus ; the external malleolus is quite close to the corresponding border of the foot ; and in front of the malleolus there is a hollow. In front of the lower end of the tibia there is a large prominence, which can be recognized as the astragalus by the characters of its surfaces ; it may be fixed or movable, and is sometimes turned sideways or completely over.

Dislocations Forwards and Outwards (*Fig.* 268).—The foot is inverted ; the external malleolus very prominent ; on the inner border of the foot there is a hollow behind the tubercle of the scaphoid. The displaced astragalus forms a large prominent swelling, distending the skin in front and externally, over the cuboid.

Reduction.—An assistant holds the foot with his two hands, by the heel and the metatarsus, and **forcibly extends it,** while the operator, standing in front, **pushes the astragalus upwards and backwards.** As the displacement is usually oblique, either inwards or outwards, it will be necessary first of all by lateral pressure to bring the head of the bone into the antero-posterior plane before exercising the backward pressure.

B. **Dislocations Backwards.**—The least uncommon form is the direct dislocation ; the bone is forced backwards, and lodges above the heel, between the tibia and the tendo Achillis, where it can be recognized by palpation. The natural curve of the foot is lost, the malleoli are lower than normal ; in front of the tibia, behind the tubercle of the scaphoid, a

more or less definite depression is found. There are also two very uncommon varieties: dislocation **backwards and outwards**, or **backwards and inwards.**

Reduction.—The surgeon takes the foot himself, one hand curving above the heel, the other grasping the fore part of the foot; then he pulls downwards with all his strength on the os calcis, while at the same time he tilts its posterior extremity as much as possible upwards and depresses the anterior part of the foot; in other words, he combines direct traction downwards with forced extension of the foot, in order to *open up as widely as possible the space in which the astragalus is lodged under normal conditions*, and to drive the bone forwards under the pressure of the os calcis.

Irreducible Dislocations.—Let us suppose that it has been found impossible to reduce some one of these dislocations, **sub-astragaloid,**

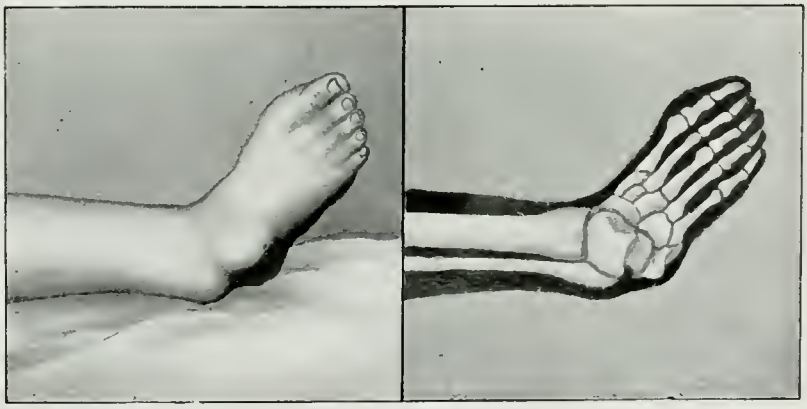

Fig. 208.—Dislocation of the astragalus forwards and outwards

tibio-tarsal, or of the **astragalus alone,** that the various reductory manœuvres, though executed methodically and under general anæsthesia, have failed. What line of action is to be adopted?

It is necessary to prepare at once for **open reduction,** even though the skin has remained unbroken and the lesion is consequently a "simple" one. Nothing is to be gained by waiting, and a delay of a day or a few days will simply add to the difficulties.

A lateral incision is made on the side of the dislocation, passing in front of the malleolus and extending as far as seems necessary on to the dorsum of the foot; if it is insufficient, a second incision will be made at the opposite side parallel to the first. The tendons will be carefully retracted and the focus of dislocation freely exposed.

Then the obstacle which prevents reduction must be looked for, such

as tendons, portions of the ruptured capsule, or an interposed fragment of bone ; and after having excised or retracted everything which appears to be in the way, an attempt will be made to restore the dislocated bones to their proper places, partly by repeating the various methods of traction and rotation, etc., on the foot as a whole, partly by measures acting directly on the exposed bony surfaces. One must not be satisfied with " practically complete " reduction, or reduction that is apparent only, or reduction which can only be maintained by the exercise of force ; exact and complete replacement is essential.

To attain the desired result, resection of bone may be necessary a complete tibio-tarsal resection will very seldom be required, often **extirpation of the astragalus** alone will suffice ; in all cases where removal of bone is necessary, it will be well to begin by resecting the astragalus, leaving any more extensive procedures, such as partial excision of the tibio-fibular notch or the malleoli, to be undertaken only if unavoidable ; in such cases care must be exercised to retain as far as possible two lateral bony processes, which will contribute in a very considerable degree to the security of the new joint.

In the case of an isolated dislocation of the astragalus, if the bone is extensively separated from its attachments and the calcaneo-astragaloid ligaments are partly torn, very often the best plan will be to perform resection as a primary measure, without making any attempt to reduce it after it has been exposed.

In these cases, it is impossible to give any very definite instructions regarding the technique of resection of the astragalus ; the operation is as a rule considerably modified and simplified by the preceding traumatism, which has already effected part of the work.

Seize the bone firmly by its dislocated extremity, and with the knife and periosteal elevator, *separate everything that holds*, keeping close to the surface of the astragalus ; as the bone is freed, raise it up and pass the knife under it *very far back*, to divide the last strands of the calcaneo-astragaloid ligament, which causes the chief difficulty in the operation ; such is, in a general way, the method to be followed.

It is quite unnecessary to try to excise the astragalus *in one piece* ; if the separation of the postero-inferior part is troublesome and takes too long a time, the bone may be broken up with chisel and mallet, and extracted piecemeal ; I have followed this excellent plan in three cases, and have nothing but praise for it.

Compound Dislocations.—Primary extirpation of the astragalus is always indicated, and is indeed urgently necessary, when the bone is found exposed and displaced in a large wound (*Fig.* 269) ; being torn away from its attachments, it can be removed very easily.

Usually, in dealing with a **compound dislocation,** the indications to be met vary according to the date of the accident, the state of the wound with regard to contamination and infection, and the obstacles to reduction. If the **injury is recent,** an effort must be made to apply the formula : **disinfection, reduction, conservation.**

Case 24.—A navvy was brought to the Beaujon Hospital in October, 1895, with a complete, open dislocation of the right foot outwards. The deformity was very great; the foot was displaced *en masse* and everted to such a degree that the sole was turned directly outwards and the external border upwards; on the inner aspect of the ankle, the tip of the internal malleolus protruded through a transverse lacerated wound about two inches in length.

After the whole of the foot had been thoroughly cleansed, the wound was freely enlarged, and it was then seen that the tibio-fibular notch was empty and exposed, and that the entire foot had been driven outwards. The whole area was freely irrigated with very warm boiled water, and all the articular recesses were carefully cleansed. Reduction was effected without much difficulty by grasping the foot with the hands and drawing it downwards and inwards. Two drains were left at the angles of the wound below the malleolus, and the foot was enveloped and fixed in a large dressing.

It will almost always be necessary to enlarge the contused submalleolar wound, so that access may be as free as possible, and to ensure thorough cleansing and good drainage. Everything, in fact, depends on the primary treatment.

If reduction is impossible, the condition must be dealt with in the manner described above.

In the presence of an **infected wound, dirty, and badly dressed,** or which has remained **without any protective dressing for several hours,** it is still advisable, as far as possible, to **try conservative measures**; by means of free incisions, prolonged irrigation with very warm water or solution of peroxide of hydrogen, and multiple drainage, it will sometimes be possible to save the limb; at any rate, by making ample provision for the escape of the discharges, the great dangers associated with the attempt will be neutralized. But very often the local lesions are such that only two methods of treatment are justifiable: **primary resection, or amputation.**

Fig. 269.—Compound dislocation of the astragalus inwards.
(A) The displaced astragalus.

I need not say that all efforts must be made to avoid the second alternative, and to save both the patient and the injured member.

When **resection** is necessary, it must be sufficiently extensive to insure adequate disinfection and perfect drainage, but without producing an excessive loss of tissue and consequently a useless foot. **Extirpation of the astragalus** may be considered as a type of these operations, but if it does not give sufficient room, it will be necessary to attack the malleoli and the lower end of the tibia.

Later on we shall consider the conditions in which the sacrifice of the limb is inevitable. (See Crushing Injuries.)

DISLOCATIONS OF THE TARSUS, THE METATARSUS, AND THE TOES.

A Mediotarsal Dislocation is a rarity; Tixier and Viannay[1] could only collect nine cases, of which only five were unquestionable. The scaphoid and cuboid together are separated from the os calcis and astragalus, and the fore part of the foot is dislocated downwards, upwards, inwards, or outwards; of these the **dislocation downwards** has most often been observed. The anterior extremity of the os calcis and the head of the astragalus make a prominent projection on the dorsum of the foot; the anterior part of the foot is thickened, globular, and shortened; the plantar arch is flattened, and the curve of the inner border has disappeared.

To effect **reduction**, pressure is exercised on the projecting head of the astragalus while the fore part of the foot is firmly abducted in order to disengage the scaphoid. The task is often very difficult; if no success attends some methodical attempts under chloroform, it will be well not to persist, and to trust to massage and local gymnastics to bring about sufficient functional restoration.

The Dislocations of the Metatarsus, which are much less uncommon, may be **total**, and involve all five metatarsals, or **partial**, implicating only one or other of the marginal metatarsals, or one or two of the intermediate metatarsals. In 68 cases collected by Bayer, in 1904, there were 34 total and 34 partial dislocations.[2]

The **total** dislocations occur most often in an outward direction (in 31 cases, MM. Quénu and Küss found 16 dislocations outwards),[3] or, more correctly, outwards and upwards. They may also occur directly upwards or downwards towards the sole. Only one case of total dislocation inwards is on record, and that is rather doubtful.

Sometimes the dislocation is **divergent**, the four outer metatarsals being displaced outwards, the first metatarsal inwards. Even when all five metatarsals are displaced to the same side, there is very often a difference in the degree of displacement, with a resulting gap between the first and second (Quénu et Küss).

Lastly, the four outer metatarsals may be displaced and the first remain in its natural position. Very often these dislocations are complicated by tarso-metatarsal fractures or by dislocations of the tarsus.

Reduction.—This must first be attempted, under chloroform, in the manner indicated by Chavasse:[4] "One assistant fixes the heel and

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[1] Tixier et Viannay, "A propos d'un cas de luxation médio-tarsienne," *Arch. prov. de chir.*, mars, 1900: and *Revue gén., Gaz. des hôp.*, 28 janvier, 1900, no. 85.

[2] J. Bayer, "Die Verrenkungen der Mittelfussknochen im Lisfranc'schen Gelenk" *Sammlung klin. Vorträge*, 1904, N F., No. 372.

[3] Quénu et Küss, "Les luxations du métatarse," *Revue de chirurgie*, 1909, pp. 1 & 281.

[4] *Revue de chir.*, 10 juillet, 1884, No. 7, p. 542.

ankle firmly, while another exercises vigorous and steady traction with both hands on the extremity of the foot. The surgeon then encircles the mid part of the foot at the site of displacement with his two hands, the thumbs on the dorsum, the fingers on the plantar aspect. The thumbs press downwards and forwards on the bases of the metatarsals, while the fingers act in the opposite direction on the cuneiforms and cuboid."

The direction of the pressure will be varied according to the nature of the displacement.

In certain cases it may be necessary to effect reduction by open methods through a dorsal or two lateral incisions. Retention is always difficult after reduction, and it is better to have recourse to massage at an early stage than to keep the foot more or less imperfectly fixed.

Dislocations of the Toes are reduced in the same way as the dislocations of the fingers; with the great toe in particular, the method already described for dealing with the metacarpo-phalangeal dislocations of the thumb must be strictly followed. In the event of complete irreducibility, the glenoid ligament must be divided, or, if necessary, the head of the first metatarsal may be excised.

SIMPLE FRACTURES.

It would be outside our limits to give a detailed description of all the various forms of apparatus, or to study the numerous varieties of fractures of the bones of the limbs. We shall therefore confine ourselves to a consideration of the subject from a practical standpoint.

First Aid.

Means of Transport.—A man breaks his leg in the street or in the open country. He must be raised and transported; this task often devolves on the first comers, but it is none the less important and difficult.

It is therefore desirable that the few practical rules which ought to govern "first aid" should be as widely known as possible.

The fractured limb must be temporarily immobilized, on the spot, before any attempt is made to move the patient, for several reasons: first, to prevent laceration of the tissues around the focus of fracture, or even secondary perforation of the skin by a sharp, projecting fragment of bone; in the second place, for the relief of pain. How much suffering, how many complications would be avoided, if more method and less haste were employed in lifting these patients, and if the instinctive tendency to move them at any cost and with any chance appliances, amidst noise and excitement, were resisted! These remarks are particularly true with regard to the fractures of the lower extremities.

The clothing must be removed with care from the damaged limb, sleeves, trousers, or underclothing being cut along the seams.

For temporary immobilization **splints** and **ties** are required; and must be improvised from whatever is at hand. It is a matter of ingenuity and common sense.

In towns and habitated districts, something can always be obtained if the trouble is taken to look or ask for it; the splints can be made with pieces of board, laths, rules, broom handles, bars, matting, wire netting, pasteboard, umbrellas, sticks, etc.

In the country or in the woods, small boughs of trees, large strips of bark, supports made up with bundles of straw, rushes, etc., or even with rolled-up garments, may be employed. In the shooting field, guns, leggings, or game-bags may be used. On the battlefield, rifles, swords, scabbards, etc., will serve the desired object.

Shortly, it is necessary to improvise two broad lateral supports, long enough to extend the full length of the limb, so as to fix the joints above and below the seat of fracture. Beneath these temporary supports or splints, padding, made up on the spot of towels, articles of clothing, wool, newspapers, straw, moss, etc., will be placed.

Lastly, if nothing is available, there remains the plan of fixing the damaged lower extremity to the sound one, fastening them together side by side, the sound limb taking the place of a splint; in the case of the arm, the side of the chest will serve as the support.

The bandages and ties can easily be made with belts, straps, strips of torn garments, handkerchiefs, etc.

There is, moreover, a correct way of raising the limb, for the purpose of fitting the splints and passing the ties. The manipulations must be governed by the fundamental principle of moving the fractured bones as little as possible. The damaged limb must therefore never be lifted by its extremity; it should be raised as a whole, one assistant grasping and steadying the upper part with both hands, while another pair of hands, gripping the ankle, pulls in the long axis. The more perfect the co-operation between the four hands, the more firmly the limb is held, the steadier and more continuous the traction, the less will be the pain and the risk of injury.

The same method must be observed during all manipulations and during transport.

As soon as the patient is safely in bed, the improvised apparatus will be removed, and the surgeon will proceed to reduction and the final immobilization.

In our opinion, the **immediate reduction** of a fracture, of the leg for example, is quite as urgent a matter as the majority of the procedures which have already been considered in these pages, and, further, reduction must be considered as an actual operation, a surgical undertaking with well-defined technique and of major importance. A repetition of these

commonplace but too often unrecognized truths, is by no means superfluous.

The treatment of fractures is not, and ought not to be, a routine task conducted by haphazard methods.

Nowadays it is recognized that there is quite a group of fractures which ought to be treated exclusively by **massage** : fractures of the fibula, of the malleoli, of the lower extremity of the radius,[1] certain fractures of the patella, of the olecranon, fractures of the upper extremity of the humerus, of the neck of the femur, etc. ; or at least in which massage ought to be begun almost immediately after a very short period of immobilization or continuous extension.

The general rule is to restrict the stage of immobilization to the shortest time necessary for the important process of consolidation ; it is none the less true that every fracture which is displaced or susceptible of displacement, ought forthwith to be reduced and immobilized.

As to the methods of immobilization, they can, after all, be reduced to certain simple types, the correct application of which must be known. Plaster apparatus in its varied forms meets all indications ; the practitioner who has plaster and can use it, and who can apply continuous extension, and Hennequin's apparatus, is in possession of all that is necessary for treating fractures, *if he knows how to reduce them.*

We shall therefore devote our attention chiefly to *reduction*—the immediate reduction—of fractures, to *the manœuvres which it necessitates*, to *the various guides useful in determining the correctness of reduction*, and shall content ourselves with describing *the most easily improvised forms of apparatus.*

I. Fractures of the Clavicle.

If the fracture is transverse or nearly transverse, *with little displacement*, or if it is at the *outer extremity* of the bone, support the limb with a well-applied **Mayor's sling,** and begin massage early.

I say a *well-applied* Mayor's sling : it is fitted in the following manner. Take a splint sheet or a large towel, long enough to go easily round the body, and fold it into a triangle. The forearm is flexed to an acute angle, and the elbow brought forwards and inwards ; the base of the triangle, kept tight, is placed across the front of the limb, as shown in *Fig.* 270, and the two angles, carried round the sides of the body, are united posteriorly by a temporary knot, which will afterwards be replaced by a safety pin or a few stitches.

Then fold the lower angle from below upwards and from before backwards below the forearm and the elbow ; the two points of the lower angle of the sling will afterwards serve for the attachment of the supporting shoulder straps. Draw the sling tight and arrange the gutter so that the limb lies comfortably in it (*Fig.* 271). The gutter will subsequently be

[1] Of course after preliminary reduction.

closed with a few pins or by stitching, so completing the envelopment of the elbow and forearm.

It only then remains to fix the supporting straps; in other words, take a piece of bandage, double it, fix the middle part of the loop to the sling behind, pass the two ends forward, one over each shoulder—which is protected by a small pad of wool—and attach them in front to the double point of the lower angle of the sling (*Fig.* 272). This excellent sling will be found very useful—if properly applied—in many injuries of the upper limb.

Fig. 270.—Mayor's sling: 1st step.

The question of treatment presents itself in a very different form in cases of complete, oblique, overlapping **fractures with considerable displacement.**

Reduction is generally easy, but maintenance of the reduced fragments in close apposition is practically impossible; union may be obtained with

Fig. 271.—Mayor's sling: 2nd step.

Fig. 272.—Mayor's sling, completed.

only a moderate amount of callus and without any very apparent deformity, but an ideal anatomical result is never obtained. This may as well be

recognized at once, but is not, however, a reason for making no attempt to influence the progress of events. In these fractures with considerable deformity there are other factors besides external form to be considered. A shortened clavicle becomes a serious hindrance to the functional usefulness of the limb, and large, irregular masses of callus are often painful, even if by compression they do not produce more serious conditions.

Therefore, always reduce the fracture with great care. Have the patient seated on a low stool; an assistant, standing behind, applies his two hands over the front of the shoulders and draws the shoulder on the injured side **upwards, outwards,** and **backwards** (see DISLOCATIONS OF THE CLAVICLE); the surgeon, standing in front, regulates the movement of the shoulder, and taking the two fragments between his thumb and fingers, makes sure that they are in satisfactory contact.

Reduction is complete when the clavicle has been restored to its natural length, that is, to the same length as the uninjured clavicle, measured from the sterno-clavicular articulation to the outer extremity, which is usually prominent and always easily found.

Fig. 273.—Double figure-of-eight of the shoulders.

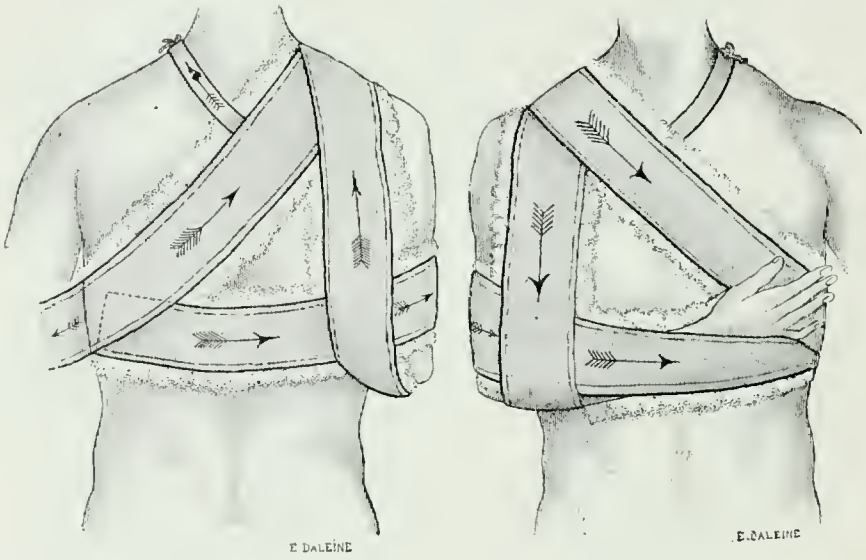
While the assistant maintains the shoulder in the correct position, the fixation apparatus must be applied. A very great variety of special bandages have from time to time been recommended, but it must be recognized that any combination of bandages, however elaborate, is sure to slip out of place within the first twenty-four hours; even though the superficial appearances may be satisfactory, the displacement will have occurred underneath. To get satisfactory results, plaster or silicate of soda must be used.

Personally, I think that the following arrangements will permit the desired object to be obtained, provided that reduction is maintained during the whole time of their application and until they have set.

(*a*). Pad the supra- and infra-clavicular fossæ and the axillæ, then envelope both shoulders and the upper part of the chest with a thin layer of wool. Take a soft roller bandage, and first pass a few circular turns around the chest, then pass obliquely from behind over one shoulder, down in front of it, under the axilla, across the back, over the other shoulder, returning obliquely to the back again. In short, describe a series of figure-of-eight loops over the two shoulders, the posterior double-crossed bandage

of the old manuals of bandaging, taking care to exercise considerable traction on the shoulders, sufficient to draw them backwards and fix them.

Over the first bandage, apply another of plaster or silica, following the same direction and describing the double figure-of-eight as before (*Fig. 273*). Take care that reduction is maintained until the plaster has set; if the apparatus has been carefully applied, though the patient may find it somewhat uncomfortable for a few hours, or even for the first few days, he will soon become accustomed to it, and it will give excellent results.



Figs. 274, 275.—Le Dentu's plaster bandage.

(*b*). Reduce the fracture as before, and apply M. Le Dentu's plaster apparatus, which is sufficiently well shown by *Figs. 274* and *275* to render any description unnecessary.

(*c*). Protect the lower half of the thorax, the elbow, and the lower two-thirds of the arm with a sheet of lint or a thin layer of cotton-wool. Pass a few turns of a muslin bandage, impregnated with plaster, around the chest, then between the arm and chest from behind forwards and around the front of the arm to the back, and draw the arm firmly backwards; repeat the turns until the arm is firmly fixed, and finally complete the apparatus by a few turns encircling arm and chest together. Take care that the bandages are firmly and evenly applied, and have the elbow held backwards until the plaster has thoroughly set (*Fig. 276*).

Lastly, let us mention, the method of treatment in bed, without any fixation apparatus and with the arm pendent, which has been recommended by M. Couteaud.[1]

The patient lies on a rather hard mattress, with the shoulders drooping backwards and the arm hanging vertically over the edge of the bed (*Fig.* 277); in this position the fragments of the broken bone fall naturally into good position, and it is maintained for fifteen or twenty days, until union has taken place. The forearm may, at least during the night, rest on a cushion supported by a low stool.

The "hanging arm" position very soon becomes tolerable, and causes only some congestion of the limb, and later some dependent œdema, which soon yields to massage.

In this manner a good æsthetic result can be obtained; it must be recognized, however, that the employment of such a method is only possible with a particularly docile patient, and though it avoids the use of any form of retentive apparatus, it necessitates remaining in bed.

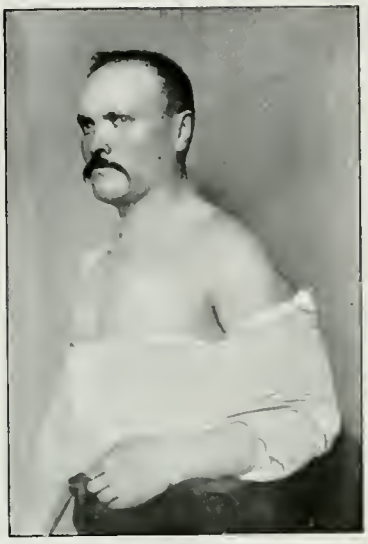


Fig. 276.—Plaster apparatus holding the arm backwards, in a case of fracture of the clavicle.

Fig. 277.—Treatment of fracture of the clavicle in the "arm pendent" position (Couteaud).

There remains the question of wiring. I have sutured fifteen or so fractured clavicles at one period or other, and I shall mention, in a few words, the indications which I recognize for operative measures.

A "cosmetic" indication need hardly be considered; apart altogether from the responsibility which is assumed in opening up a simple fracture, and while admitting that suture may be followed by ideal union, the cicatrix

[1] COUTEAUD, "Traitement esthétique des fractures de la clavicule," *Gazette des hôpitaux*, 4 septembre, 1906.

remains as an ineffaceable mark, quite as visible and quite as striking as a moderate degree of irregularity of the bone.

Personally, I consider that suture is only indicated in two conditions : (1) *When there is considerable shortening of the clavicle* owing to overlapping which is very difficult to correct ; (2) *When there is compression of nerves.*

In any case, it is never an operation of immediate urgency, and for its technique we refer the reader to the chapter on OPERATIVE UNION OF FRACTURED BONES.

II.—FRACTURES OF THE SCAPULA.

A few words with regard to these will suffice : first, on the **fractures of the body and the spine** ; and then on those of **the surgical neck.**

The fractures of the spine and the acromion can easily be detected on careful examination. Those of the body, implicating the supra- or infra-spinous fossæ, present greater difficulties ; to recognize them, the examining hand is applied broadly over the retro-scapular region, and the arm is

Fig. 278.—Examining the scapula for a fracture.

moved in a forward and outward direction ; in this manner, if a fracture is present, crepitus may be detected. Another method, which is much to be recommended when the patient is not too stout, consists in seizing the lower part of the scapula transversely as shown in *Fig.* 278, and moving the arm. Mayor's sling and massage constitute all the treatment necessary.

As to the fracture of **the surgical neck**, it detaches the glenoid and the coracoid process in one piece, and rare though it is, it must be kept in mind, because it may easily lead to a mistaken diagnosis.

The shoulder hangs down, the acromion process is prominent, and the deltoid region flattened; at first sight, one might think that there was a dislocation of the shoulder. But the arm hangs vertically in a normal position, and is not fixed; there is no deltoid depression, and on closer examination it is evident that it is the shoulder as a whole which has slipped down; lastly, apply the left hand over the shoulder, and with the right grasp the elbow and try to push the arm directly upwards in the axis of the humerus; it ascends readily, and the deformity disappears, and generally crepitus will be felt.

It is in this elevated position that the arm must be secured.

III.—Fractures of the Arm.

Fig. 279.—Fracture of the shaft of the humerus; fragments overlapping.

Here is **a fracture of the shaft of the humerus**, with considerable mobility, shortening and angulation of the arm at the position of the overlapping fragments (*Fig. 279*).

If the patient must be moved, or if it is necessary for any reason to delay the application of the final fixation apparatus, envelope the arm

with a thick layer of wool and fix it to the side of the chest, which will serve as a support, by some turns of a bandage; the lowermost turns encircle the elbow and raise and fix the forearm in front of the chest.

As soon as possible, reduce the displacement and fix the limb.

Fig. 280.—Compression of the musculospiral nerve by callus after a fracture of the humerus (the nerve is enclosed in a bony tunnel)

To effect reduction, have the patient seated on a chair; a folded towel is passed under the axilla, and by means of it an assistant standing on a chair behind the patient makes traction *vertically upwards*. The operator flexes the forearm to a right angle, and holding it with one hand and grasping the lower part of the arm above the condyles of the humerus with the other, he gently disengages the fragments, and pulling downwards in the axis of the humerus restores the normal length and form to the arm.

Reduction is correct when **the epicondyle** turned forwards, **the great tuberosity of the humerus,** and **the tip of the acromion, lie in the same straight line.**

It is usually a good sign to hear coarse, bony crepitus during these manipulations; if it is absent, remember the possibility of *the interposition of muscle tissue*, which is by no means uncommon in the arm; and by inclining the lower fragment to one side or the other, and by communicating a slight rotatory movement to it, try to disengage the point and establish definite bony contact between the fragments.

Further, if the manipulations are excessively, abnormally painful, if the pains radiate over the whole of the limb, if the pushing up from below and the contact of the two fractured surfaces provokes and exaggerates these radiating pains, there will be reason for thinking of another possible complication of these fractures of the shaft of the humerus, *inclusion of the musculospiral nerve between the fragments.*[1]

[1] It is always necessary to think of the musculospiral nerve after fractures of the shaft of the humerus, and to determine the contractility of the extensors by making the patient

By the movements of flexion, rotation, and circumduction of which we have already spoken, an effort will be made to disengage it ; the failure of these attempts, and the persistence of an acute radiating pain and numbness of the forearm after reduction has been effected, will indicate the need for immediate operation. Too often, however, the complication is only recognized at a late period (*Fig.* 280).

General anæsthesia is an almost indispensable preliminary to any reduction ; but in the arm it is usually less difficult to reduce the fragments than to retain them in good position after reduction, and for that reason **it ought to be the rule not to relax extension and counter-extension until the plaster apparatus is perfectly dry.**

This rule is a fundamental principle of **Hennequin's apparatus**, an apparatus which complies with the other general condition for the treatment of diaphyseal fractures : *the fixation of the joints above and below the fractured segment.*

The patient is seated. First, *provide extension and counter-extension.* The wrist, forearm, elbow, and lower fifth of the arm are enveloped in a thin layer of wool and bandaged ; a piece of wool, retained in position by a fold of gauze the ends of which are tied together over the shoulder, protects the axilla. The forearm is flexed to a right angle and supported by a bandage arranged as shown in *Fig* 281.

A broad bandage or a folded towel is passed under the axilla and fixed to a hook or ring, or the framework of the bed, vertically above the shoulder. **That is the counter-extension.**

Fig. 281.—Fracture of the arm (Hennequin's plaster apparatus). Extension and counter-extension.

Another piece of bandage, about three feet in length, is placed over the posterior aspect of the lower part of the arm, the ends are brought round to the front of the limb and crossed over the upper part of the forearm,

extend the wrist and fingers, not only immediately after the injury, but during the course of the after-treatment. If the initial paralysis is incomplete and not painful, if the signs described above of inclusion of the nerve between the fragments are not found, it will be reasonable to diagnose a simple contusion of the nerve, and to proceed to apply the fixation apparatus ; if the signs diminish during the following weeks, the diagnosis is confirmed, and unless secondary compression by callus supervenes, spontaneous recovery is practically certain. Progress in the opposite direction necessitates operation, which, even when undertaken at a late stage, gives a considerable proportion of functional recoveries. (See our article with P.-E. Launois, "Résultats des opérations libératrices du nerf radial après les fractures de l'humérus," *Revue de chirurgie*, 10 mai, 1903, No. 5, p. 574.)

and allowed to hang vertically; to each end a 2-lb weight, or any heavy object of approximately that weight, is attached. That is the extension.

These preliminary details demand careful attention; under the influence of the vertical traction, the fragments will return to their natural

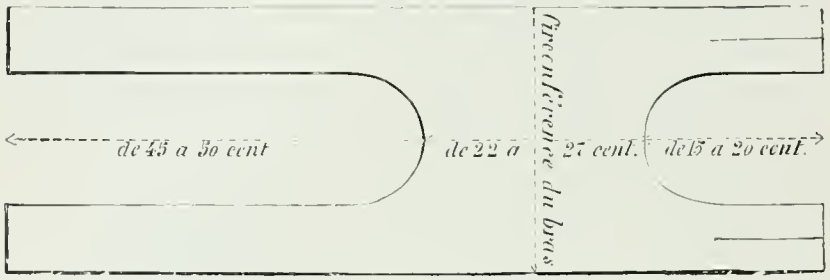


Fig. 282.—Diagram showing shape and dimensions of the splint in Hennequin's apparatus for fracture of the arm.

position, and reduction be effected—spontaneously, so to speak—while the other preparations are being made. Therefore, do not hurry; give the muscles time to become fatigued and gradually relax.

Cut out the apparatus as shown in *Fig.* 282; take sixteen pieces of coarse muslin, each about three feet long, and in breadth equal to the circumference of the middle part of the arm, and superimpose them.

Fig. 283.—Fracture of the arm: Hennequin's plaster apparatus applied.

In the upper and lower borders cut two deep notches, one 15 to 20 cms. (6 to 8 in.) deep at the upper border, the other 45 to 50 cms. (18 to 20 in.) at the lower border; the intermediate portion, which is to form the body of the splint, must be of the same length as the arm, measured from the fold of the elbow to the axilla (22 to 27 cms. or 9 to 11 in.).

It will be seen immediately how the two upper and two lower bands, when crossed over the shoulder and twined around the forearm respectively, will serve to immobilize the two articulations above and below the seat of fracture.

Next, the system of extension and counter-extension remaining in action, reduction being complete and the limb having recovered its normal length, *proceed to apply the*

apparatus, thoroughly impregnated with fluid plaster; fit the upper notch under the lower border of the axilla, the lower notch over the bend of the elbow, and fold the margins of the body of the splint around the arm in front and behind. Each of the upper tails is split longitudinally, and the two resulting pairs of ends are imbricated over the shoulder; the two lower ends are rolled around the forearm, each in opposite directions like cross-gartering, to end at the styloid process of the ulna (*Fig.* 283).

The extension and counter-extension—this point is essential—must not be discontinued before the apparatus is perfectly dry and firmly set.

Sometimes it may be necessary to fit the apparatus with *the patient lying down*; the same method of effecting reduction must be employed; a band passed under the axilla and fixed at the head of the bed, etc., or kept taut by the hands of an assistant, will insure counter-extension, while horizontal extension in the axis of the limb will be continued during the application of the apparatus and until the plaster is quite dry.

Such is Hennequin's apparatus, which may be improvised anywhere if the principle has been grasped.

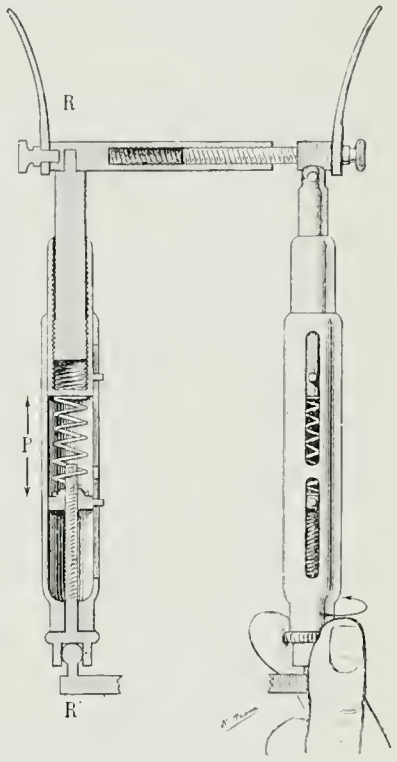


Fig. 284.— Heitz-Boyer's extension-tubes. The two tubes used for the arm, united above by the axillary cross-piece (R); the tube on the left is shown in longitudinal section. (P), the internal spring; (R'), the base-plate, on which the cup-shaped lower extremity of the extension-tube rests; on the right, the screw is being turned and the spring compressed.

M. Heitz-Boyer has devised a method of treatment, the technique of which is more difficult, and which for its proper application requires the repeated use of radioscopy; but, on the other hand, very exact adjustment of the fragments can be obtained by its means.

The results which have been obtained up to the present time suffice to show what may be expected from it in the treatment of oblique, overlapping, and primarily badly reduced fractures, and the decided advantages to be gained from its use.

The special appliances required are: (1) *Extension-tubes*; (2) *Rubber cushions* of special shape, filled with either water or air, according to the case.

1. **The extension-tubes** (*Fig.* 284) are of aluminium, and consist of three telescoping tubes, the relative positions of which can be varied by

appropriate mechanism ; the upper and smallest tube moves within the second by means of a helical screw ; to give the extension tube the length required to suit any arm, all that is necessary is to screw the upper tube in or out. The middle tube lies free in the large tube, but below its base there is a spiral spring[1] resting on a circular disc, which can move up or down in contact with the walls of the large tube ; the disc is supported, and its position within the large tube is regulated, by a screwed stem which is adjusted by an external milled head at the base of the large tube. By turning this screw, the disc is moved up or down, and compresses the spiral spring, which reacts on the middle tube and adjusts the length of the extension tube as required ; when the tube is in position, interposed between two fixed points, it exerts a varying amount of elastic force, according to the degree of compression of the spring, which can be ascertained by inspection through the longitudinal slot in the wall of the large tube.

The extension force obtained by the use of these tubes can be very definitely estimated, and can be varied at any time by simply turning the external screw.

For the arms, two extension-tubes are required, and the upper ends are united by an axillary cross-piece ; the anterior tube is screwed to the cross-piece, the posterior tube is attached with a movable joint. The cross-piece itself consists of two metal rods fitting one into the other, with male and female screws, by means of which any required length can be obtained ; lastly, the ends of the cross-piece bear projecting bars which rest in front and behind the axilla, and prevent the apparatus from slipping backwards or forwards.

2. **The rubber cushions** are provided with tubes and taps ; they are used as pads between the skin and the ends of the extension-tubes, or, again, they may be used to effect reduction ; in the first case they are filled with water, in the second, distended with air, as we shall mention presently. They may be simply oval, or of varying shapes, according to the surfaces to which they are destined to be applied.

Shortly, the method of using the apparatus for a fracture of the arm is as follows.

1st step.—The patient is seated ; counter-extension is provided by means of a band passed under the axilla and attached above to some fixed point—in default of anything more suitable, to a long-handled broom tied to one of the legs of the chair (Hennequin). The limb is carefully bathed with spirit, then a sleeve of fine elastic material is drawn on ; to put on the sleeve, it is rolled up, the opening is stretched with both hands, and it is slipped over the patient's hand, and then unrolled gently right up to the axilla, and carefully stretched to remove any wrinkles. The forearm is flexed to a right angle, and the wrist supported by a strap passing over

[1] We may mention that extension by means of a spring apparatus had previously been employed by M. Pierre Delbet.

the shoulder ; the limb must be kept in this position during the whole of the subsequent manœuvres (*Fig.* 285).

Fig. 285.—Heitz-Boyer's apparatus. Position of the patient; counter-extension by means of a broom.

Fig. 286.—Heitz-Boyer's apparatus. The arm and forearm cushions in position.

2nd step.—**The Application of the Cushions.**—A single cushion, adapted to the upper part of the forearm, may suffice ; it is often better, however, when reduction is likely to be troublesome, to place a second over the epicondyle and epitrochlea.

The forearm cushion is placed immediately in front of the fold of the elbow over the prominence of the supinator longus ; it is oval in shape ; it is moderately filled with tepid water, and is fixed in place by a few turns of a soft bandage (*Fig.* 286).

The brachial cushion consists of two lateral portions united by a broad band (*Fig.* 287) ; the lateral portions are applied, one immediately above the epicondyle, the other above the epitrochlea, and the whole cushion is secured by bandaging.

Fig. 287.—Heitz-Boyer's apparatus. The double arm cushion properly applied over the epitrochlea and epicondyle.

3rd step.—**The Construction of a Plaster Case** which encircles

the upper third of the forearm and the lower third of the arm, and in which the base-plates are embedded.

These **base-plates** are composed of a copper plate with a projecting arm bent at a right angle, on the rounded tip of which the cup-shaped base of the extension-tube rests ; they form the lower points of support.

Take a plaster bandage and apply it from below upwards, then down and up again, until seven or eight layers have been applied ; put the two base-plates in position, the one in front, immediately above the bend of the elbow (*Fig.* 288), the other symmetrically on the posterior aspect, and fix them by five or six further turns of the bandage. Do not apply the bandage too tightly, especially on the forearm, where the movements of pronation and supination ought not to be abolished.

Fig. 288.—Heitz-Boyer's apparatus. Making the plaster case ; putting the base-plates in position.

Fig. 289.—Heitz-Boyer's apparatus. Putting the extension-tubes in position.

Complete the filling of the cushions by injecting warm water with a syringe, and leave the apparatus for an hour or two to dry thoroughly.

4th step.—**Fitting the Extension-tubes.**—We have already said that the tubes were united by an axillary cross-piece, and that the lengths of tubes and cross-piece could be varied by a very simple mechanism. Place a small cushion on the upper border of the cross-piece, secure it in position with a few turns of bandage, and fill it with tepid water.

The appliance is now ready ; slip it to the inner side of the arm under the axilla (*Fig.* 289), fit its upper portion carefully under the hollow of the axilla and to the anterior and posterior borders, adjust the extension tubes, and apply their cup-shaped lower ends over the arms of the base-plates embedded in the plaster case. Now is the time for exerting the necessary extending force ; by turning the two lower screws the tubes are lengthened,

the elbow is pushed downwards, and more or less powerful traction is applied to the lower fragment of the humerus. The extending force can to a certain extent be estimated, as we have already said ; it ought to be moderate at first, but it often happens that it diminishes very rapidly because of the yielding of the axillary tissues, and at the end of some hours it will be necessary to give a few more turns to the screw.

Next day the extending force is increased up to 2 or 3 kilograms (5 lb.), and the result obtained is determined by radioscopy ; and the work of gradual reduction is pursued in this way from day to day. In a recent fracture the overlapping, according to M. Heitz-Boyer, disappears in about forty-eight hours ; a longer time is required when treatment is undertaken rather later. If any lateral displacement persists, a cushion is arranged

Fig. 290.—Heitz-Boyer's apparatus. Inflation of the cushions.

Fig. 291. — Heitz-Boyer's apparatus. The arm maintained in a position of abduction by a cushion interposed between its inner surface and the thorax.

over the projecting fragment, and is secured in position by a few turns of bandage which take their point of support from the opposite extension-tube ; the cushion is then inflated with air, and exercises continuous pressure, which forces the bony prominence back into line. If necessary, several cushions in different positions may be employed ; the air-pressure in any one of them ought not as a rule to exceed 150 grams (approximately 5 oz.) ; it is measured by means of a small gauge fitted to the tip of the syringe (*Fig.* 290).

Often it will be very useful to keep the arm in a position of abduction, particularly in fractures below the deltoid insertion, in which the upper fragment projects outwards ; a fairly large cushion interposed between the arm and the thorax, and fixed by a bandage around the body, will maintain the limb in the required position (*Fig.* 291).

By the ninth or tenth days, the fragments are generally in good position. The extension apparatus is kept in action and constantly supervised, and massage of the arm and movements of supination and pronation

of the forearm are begun. Towards the eighteenth day the condition of the fracture is again carefully verified by radioscopy, and if the slightest displacement persists or has recurred, a fresh cushion will be applied in an appropriate position, or the extending force increased. By the twenty-fifth day, the callus is fairly strong; the forearm portion of the plaster case will be removed, and the extension afterwards applied through the epitrochleo-epicondyloid cushion alone, and movements of flexion and extension of the forearm commenced.

By about the thirty-second day, if radioscopy shows a well-defined, regular callus, the whole apparatus will be removed and the further treatment carried out by means of movement and massage.

This is a very interesting method, which, however, demands much care and constant supervision; by means of it very complete osseous repair can be obtained, and also rapid functional restoration, thanks to the massage and electrical treatment applied from the beginning, and to the early mobilization of the elbow and shoulder.

FRACTURES OF THE UPPER EXTREMITY OF THE HUMERUS.

These are complex injuries, the diagnosis of which too often remains uncertain, and which then terminate in complete uselessness of the limb.

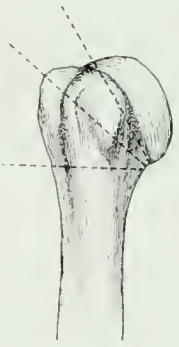


Fig. 292.—The lines of fracture of the upper extremity of the humerus. Diagrammatic.)

Suppose that the accident is a few hours old; one finds the shoulder and the upper part of the arm enormously swollen and deformed, all movement is abolished, and any attempt at examination causes intense pain and excites defensive muscular reactions.

What are the possible lesions? It may be a simple contusion, dislocation of the shoulder, fracture of the surgical neck or of the head of the humerus (*Fig. 292*), or fracture and dislocation combined. It is of capital importance to fix the diagnosis—at least in so far as it is possible—at once, and if necessary a general anæsthetic must be employed.

Do not waste time in haphazard palpation, groping indefinitely over the surface of the injured area. *First find the tip of the acromion*, apply the thumb below it, and see if the tissues can be depressed; if the thumb is arrested by a hard, rounded prominence, which fills the subacromial space, one may conclude that the head of the humerus is in its proper place, and that there is no dislocation. The conclusion will naturally be reversed if the thumb sinks without resistance into the front of the shoulder below the tip of the acromion. And so, one point is settled.

The thumb remaining in place under the tip of the acromion, and the fingers being applied below the posterior border of the process, one will

succeed in seizing and fixing the upper end of the humerus by gradually depressing the infiltrated soft tissues. With the other hand, grasp the elbow firmly; then press vertically upwards in the axis of the humerus (*Fig.* 293); if there is a fracture, this longitudinal pressure will provoke an acute pain at the site of the lesion.

Fig. 293.—Examination of the shoulder and arm.

With the "lower" hand, endeavour to impart an alternating rotatory movement inwards and outwards to the limb; if there is a dislocation, the attempt will fail, or at most only very little rotation will be obtained; in case of fracture of the neck of the humerus, it will be recognized that the head does not move below the acromion, that the rotation occurs lower down, and is usually accompanied by crepitus. In those antero-posterior displacements where the lower fragment is drawn upwards and shows itself prominently below the coracoid, the surgeon will be able to convince himself that it is the subcoracoid prominence which rotates and moves, and not the head of the humerus, which remains immobile under the acromion.

Still maintaining the two hands in the same position, carry the elbow outwards, in abduction; in the case of a fracture the movement is usually easily effected, and an abnormal depression will appear in the upper part of the arm at the level of the break.

These primary and indispensable investigations will be completed by a careful "analytical" examination of the point of the shoulder, its anterior wall, and the axilla.

1. **Fracture of the Surgical Neck, Transverse or nearly so, without overlapping, with slight displacement inwards of the lower fragment** (*Fig.* 294).—This is a simple case, which is best treated by systematic and long-continued massage. Between the sittings the arm will be supported by a Mayor's sling.

But the displacement is often very different, and necessitates reduction and immobilization, at least for a time.

2. **Oblique Fracture of the Surgical Neck, with great overlapping** (*Fig.* 295).—The lower fragment is drawn upwards, inwards, and forwards, under or even to the inner side of the coracoid process; it simulates the deformity of a dislocated shoulder, and the sharp extremity may even perforate the skin; the arm, measured from the acromial angle to the external condyle, is notably shortened.

How often has this fracture been confused with a dislocation of the shoulder! An attempt is made to reduce it; the subcoracoid projection becomes less prominent, the deformity less evident, it is imagined that "things have been put right" more or less, and the arm is fixed in a sling;

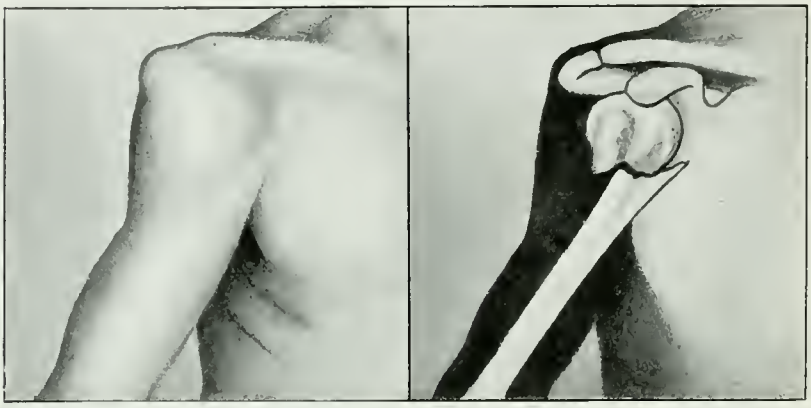


Fig. 294.—Fracture of the surgical neck of the humerus, with moderate displacement of the diaphyseal fragment inwards.

some time later, when the swelling has subsided, it is seen that the head of the humerus is in its proper place, but the anterior projection and the displacement still exist, and the arm is completely useless. It is then

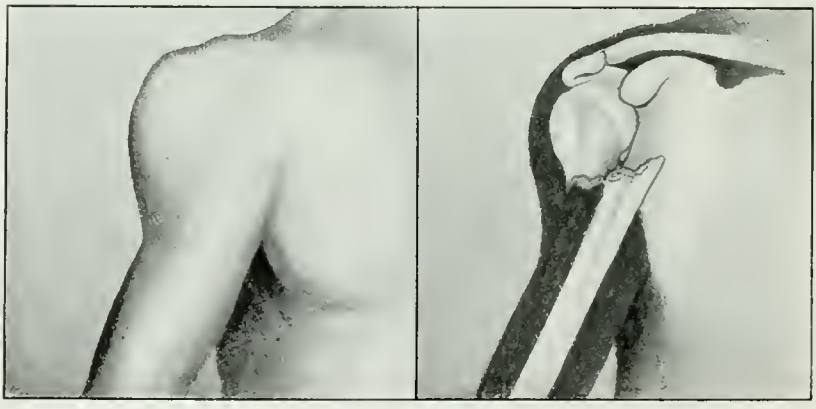


Fig. 295.—Fracture of the surgical neck of the humerus with great displacement.

necessary to look to operative measures, which are always rather difficult, to effect functional restoration. Therefore, explore very carefully both the anterior prominence and the region immediately below the clavicle, and if there is any doubt, put the patient under an anæsthetic; it is always

worth the trouble, for the future functional value of the shoulder to a great extent depends on this first examination, on the diagnosis which is made, and the treatment which follows.

Careful palpation under the acromion will demonstrate that the head of the humerus is still in place ; and if the subcoracoid prominence is made to project still more by carrying the elbow backwards, the surgeon will be able to satisfy himself that it is not smooth and spherical like the upper articular extremity of the humerus.

Sometimes there is an angular deviation outwards at the site of fracture, producing a deformity like a hockey stick (*Fig.* 209).

The displacement must be reduced, and Hennequin's apparatus applied.

Vertical traction is as a rule insufficient to effect reduction ; begin by disengaging the upper end of the lower fragment by exercising traction

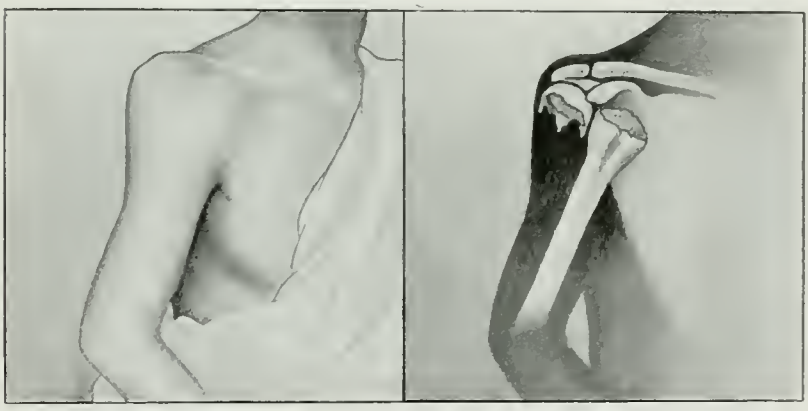


Fig. 206.—Separation of the upper humeral epiphysis, with displacement.

on the arm, above the elbow, obliquely downwards and outwards ; the force must be slowly and steadily applied with the hand or in the form of elastic traction, with a band round the arm and rubber tubing, in the manner already described.

Never apply the plaster apparatus until the arm has recovered its natural length, until the subacromial hollow and the subcoracoid prominence have disappeared, and the tip of the acromion and the epicondyle occupy their normal situation in the same vertical line, and until the fingers palpating the axillary surface of the arm come against no irregular bony projection and can penetrate to the bottom of the axillary cavity.

Here, again, M. Heitz-Boyer's apparatus (see *ante*) will be very useful.

3. **Fractures of the Head of the Humerus** (of the anatomical neck, of the great tuberosity).—In these cases a precise diagnosis cannot

be expected ; in fact, it is impossible from clinical signs alone. The point which must, however, be established at once, is the presence or absence of displacement of the head of the humerus. Radiography is indispensable for determining in detail the nature of the fracture.

The variety represented in *Fig.* 297 may be considered as the most common ; the extensive hæmorrhagic effusion, the local pain provoked by pressure in the long axis of the bone or by direct pressure at the junction of the head and neck, are always valuable diagnostic points ; the impaction of the fractured surfaces often prevents discovery of

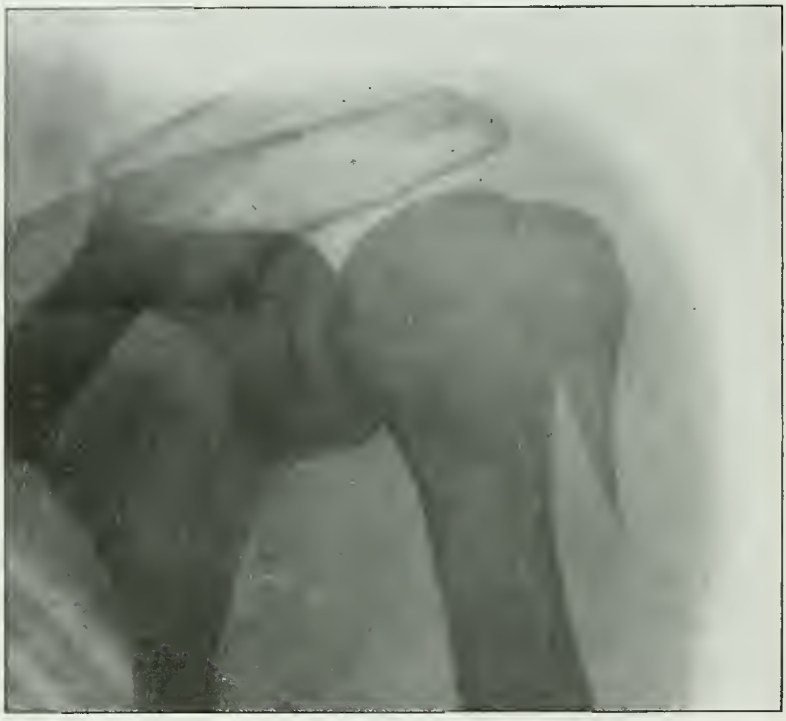


Fig. 297.- Fracture of the anatomical neck and of the great tuberosity.

crepitus. These fractures without displacement should not be immobilized ; a simple sling and massage, commenced at once, and very quickly combined with movements and local gymnastics, provide the best means of saving the function of the shoulder joint.

If, however, the diaphyseal fragment is markedly inclined outwards, it will be advisable first of all to effect reduction, under chloroform, by fixing the head of the humerus with one hand, and with the other bringing the arm into the vertical axis in order partly to break down the impaction

In this group of fractures there are some other varieties which require mention :—

(*a*). There is no impaction, the head and the two tuberosities are widely separated and freely movable ; it is **a comminuted fracture of the upper extremity of the humerus.** In such a case, it will be advisable to support the arm with a well-applied Mayor's sling, to begin massage of the shoulder at once, and to defer systematic movements for a week or two.

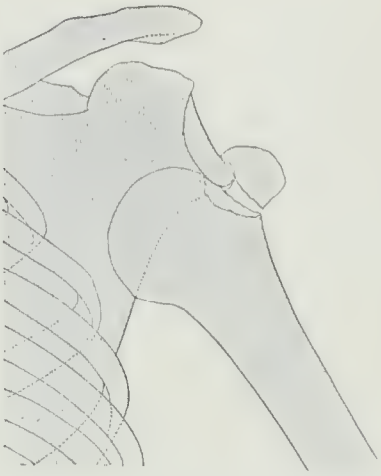


Fig. 298.—Dislocation of the shoulder, with separation of the great tuberosity.

(*b*). **The head of the humerus alone is fractured** (or fissured) in two or more places, or is separated in one piece at the anatomical neck.

Both conditions are uncommon ; radiography alone can demonstrate the exact nature of the lesion. In a case of "decapitation" properly so-called, the head may remain in more or less perfect contact with the neck, or be inclined in any direction ; it may even be turned completely round, with the cartilage-covered surface outwards, and the plane of fracture inwards towards the glenoid cavity ; it then forms a sort of loose body in the joint and cannot be reduced, and must be removed, as in the cases where the separated head is dislocated into the axilla (see later).

(*c*). **The tuberosities alone are fractured, particularly the great tuberosity.** The fracture is very easily overlooked when the bony process is not displaced. Sometimes the great tuberosity, retracted by the muscles inserted into it, slips upwards and gets caught between the acromion and the head of the humerus. Such a condition can be reduced neither by manipulation nor apparatus, and it very greatly interferes with the mobility of the shoulder ; it must be dealt with by operation, the displaced bone being reduced and fixed (by suture, staple, or screw : see later, SUTURE OF BONES), if possible, or excised subperiosteally.

Separations of the tuberosities are fairly common complications of dislocations at the shoulder (*Fig.* 298).

4. **Fracture and Dislocation Combined.**—More serious are the cases in which the dislocation is associated with a fracture of the surgical neck or of the articular extremity. In these injuries the diagnosis is difficult, the treatment troublesome, and the prognosis always bad, and it is necessary to mention at once the probability of lasting impairment

of function. When unrecognized, they sometimes leave very considerable deformities (*Fig. 299*) and permanent disability.

The dislocation has been discovered; the easily recognizable head of the humerus lies below or to the inner side of the coracoid, but the arm is not in fixed abduction, it hangs pendent by the side of the body. On rotating the arm inwards or outwards, the head moves very little or not

Fig. 299.—Fracture of the surgical neck of the humerus, with angular deviation outwards and dislocation of the shoulder.[1]

at all; the rotation takes place below and to the outer side of the head, and at the same level crepitus and all the signs of a fracture are detected.

Dislocation of the Shoulder and Fracture of the Surgical Neck of the Humerus.—In such a case, endeavour to reduce the dislocation

[1] Radiograph taken after union had occurred, the patient having been admitted to our hospital service two months after the accident. The head of the humerus was resected with only a very moderate functional result, atrophy of the muscles about the joint being very great, and the patient more than 55 years of age, but the pain disappeared.

at once in the following manner. The patient is anæsthetized. Make traction on the arm above the elbow, in a vertical direction parallel to the trunk. The traction must be very gentle and steady; if forcibly and roughly employed, it will simply aggravate the lesions, but when slow and methodical, acting through the retinacula, the bridges of periosteum, and fibrous tissue which still connect the two fragments, it will gradually, in some measure at least, draw down the head, disengage it from the coracoid process, and approximate it to the axilla.

Then, while an assistant holds what has just been gained, the operator, hooking his fingers over the posterior border of the acromion, applies his thumbs to the rounded prominence of the head and presses it outwards.

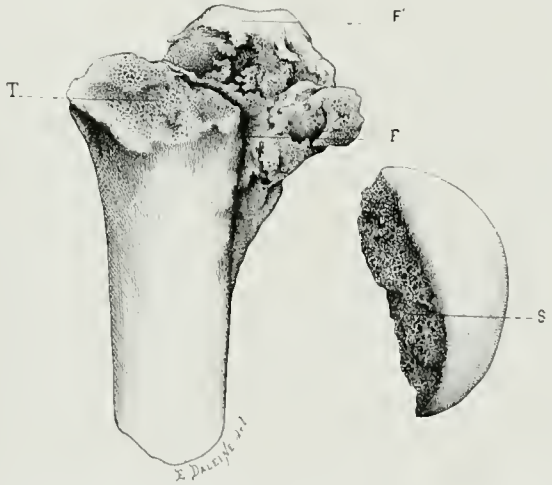


Fig. 300.—Dislocation of the shoulder complicated by fracture. (S) The separated humeral head which had been displaced into the axilla. (T) The plane of fracture corresponding to the anatomical neck. (FF') Great tuberosity, also fractured.

Employed immediately, in a recent injury and under general anæsthesia, this method has repeatedly proved efficacious; of course, if reduction is obtained, the limb will be fixed at once in Hennequin's apparatus.

If unsuccessful, the only choice remains between two procedures: *to apply no fixation apparatus and to begin massage and movements at once*, so as to save as much as possible of the usefulness of the shoulder; or *to expose the head by a long anterior incision*, over the interval between the pectoral and deltoid muscles, to disengage it and reduce it, or—and often better—excise it. There is another condition in which reduction can practically never be achieved except by operative measures: **the fracture involves the anatomical neck, and the detached head is dislocated into the axilla.**

Case 25.—A fat woman, 57 years of age, had fallen on the left shoulder. The arm was quite powerless, the shoulder was flattened, the acromion

prominent, the subacromial region depressible; in front, a prominence showed itself under the anterior wall of the axilla, and in that position, a hard, indefinitely-rounded mass could be felt, evidently in continuity with the shaft of the humerus, through which movements could be communicated to it. In the axilla, apparently almost under the skin, another tumour could be felt quite distinct from the first, and separated from the inner surface of the humerus by a definite interval; it was rounded, regular, and smooth, and presented all the characters of the head of the humerus.

At the operation, the decapitated upper end of the humerus was found projecting under the coracoid and the detached head in the axilla (*Fig.* 300).

In such conditions, any attempt at reduction by external manipulations is almost always useless, and even if the detached head could be pushed into contact with the humerus, it would not remain in position.

Here, again, the only choice lies between two plans: to begin movements and massage at once, leaving the head in the axilla as a sort of foreign body; or if the head is causing trouble, compressing the axillary vessels or nerves, to excise it, and, as before, begin massage and movements at once

5. **Separation of the Upper Epiphysis of the Humerus** (*Fig.* 296).—This is a common accident in young people. The separation may be associated with no displacement; the diagnosis is then made from the fixed, localized pain at the level of the epiphyseal line, and the uselessness of the arm.

Very often the lower fragment is carried upwards and inwards towards the coracoid process, producing a rounded prominence and a deformity of the shoulder which at first sight closely simulates a dislocation. But dislocations of the shoulder are very uncommon in children; further, a systematic examination will show that the head is still in its normal position under the acromion.

These separated and displaced epiphyses are usually very difficult to reduce, and primary reduction by open methods is often necessary. When unrecognized or incompletely reduced, they give rise to very troublesome formations of callus, and necessitate secondary operations, which we have discussed in a paper published in 1894.[1]

FRACTURES OF THE LOWER EXTREMITY OF THE HUMERUS.

We shall not dwell upon the isolated fractures of the epitroclea or epicondyle; special attention, however, must be given to the line of treatment to be adopted in the much more difficult cases of **supracondyloid fractures with displacement, the fractures of the internal or external condyles,** and those **comminuted fractures** where the elbow is actually splintered into many pieces; and in all of these conditions it is often exceedingly difficult to make an exact diagnosis.

[1] "Les cals vicieux de l'extrémité supérieure de l'humérus et leur traitement opératoire." *Revue de chir.*, 1894, p. 632.

Here, again, the utmost care must be exercised in examining the swollen, distorted, and useless elbow, and in determining the nature of the lesions; a general anæsthetic is necessary if the examination is to be satisfactory.

Supracondyloid fracture, or dislocation backwards of the elbow? Fracture of the internal condyle, of the external condyle, or lateral dislocation? These are the questions which often present themselves after a violent injury, and their solution may be extremely difficult. It may be noted that fractures of the elbow (lower extremity of the humerus and upper ends of the bones of the forearm) are particularly common in children and in young persons under the age of twenty years. In 122 traumatisms of the elbow—radiographed—in children, Mouchet found 105 fractures of the lower end of the humerus, 6 fractures of the olecranon,

Fig. 301.—Examination of the elbow. Seeking the head of the radius.

5 fractures of the neck of the radius, 1 fracture of the coronoid process, and 7 dislocations of the elbow backwards.[1] Separation of the lower humeral epiphysis appears to be very uncommon.

Before anything else, **look for the landmarks** (*Figs.* 301, 302, 303, 304): the olecranon, the epicondyle, the epitrochlea and the head of the radius. Remember that in case of dislocation backwards—with the forearm semiflexed—the olecranon projects markedly behind the plane of the condyles, and lies above them when the forearm is extended.

The question of dislocation being eliminated, any one of the following fractures may be present.

(*a*). **Supracondyloid Fracture.**—Almost always, the line of fracture

[1] A. Mouchet, *Fractures de l'extrémité inférieure de l'humerus avec radiographies.* Thèse de doct., Paris, 1898.

is oblique from behind, downwards and forwards, and the upper fragment lies in front of the lower, and if allowed to remain unreduced, ultimately forms a large mass of callus which interferes seriously with flexion; the

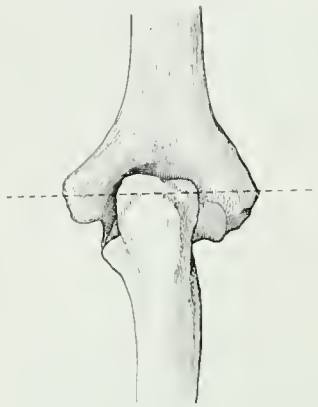


Fig. 302. — Normal relationships of the olecranon and the humeral condyles. Elbow extended.

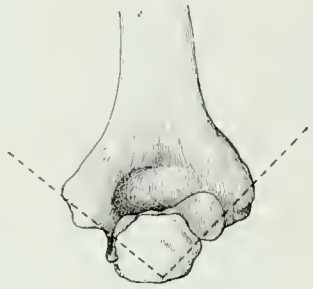


Fig. 303. — Normal relationships of the olecranon and the humeral condyles. Elbow flexed.

elbow projects prominently backwards, and the deformity simulates and may easily be mistaken for a dislocation backwards (*Fig.* 305). *Fig.* 306 shows the displacement very well; it is a radiograph of the right elbow

Fig. 304.—Examination of the elbow. The olecranon and the two humeral condyles.

of a girl, 12 years of age, in whom, on the removal of the plaster case, on the eighteenth day after the accident, very considerable functional disability was found; flexion was arrested at a right angle by a bony

obstruction, the character of which was revealed by the radiograph; extension also was considerably limited.

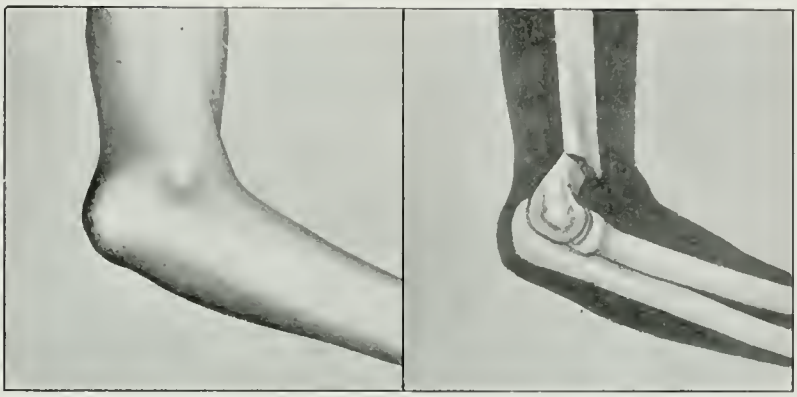


Fig. 305.—Supracondyloid fracture of the humerus.

The irregular mass of callus was exposed by a lateral incision and divided; the two fragments were restored to correct position, and the

Fig. 306.—Fracture of the lower extremity of the humerus. Displacement of the upper fragment forwards.[1]

[1] In this radiograph, taken on the twentieth day, observe the blackish triangle which appears above the displaced epiphyseal fragment and is prolonged to a point behind the humerus; it is a mass of new-formed bone, produced by the stripped-up periosteum. Such stripping up of the periosteum is often very extensive in fractures of the lower end of the humerus, particularly in children, and the new-formed bone plays a very important part in the causation of the functional disturbances which follow incomplete reduction.

elbow was fixed in a position of extreme flexion. The fixation apparatus was removed on the twelfth day, and massage and local gymnastics commenced at once ; this time a movable articulation and complete restoration of function were obtained.

This antero-posterior displacement, visible at first sight, is almost always associated with a lateral displacement, which is less evident and sometimes unrecognized. The lower fragment is not carried directly behind the upper one, but backwards and inwards or backwards and outwards, and permanent cubitus varus or valgus results if lateral reduction is not effected. This transverse deviation is only evident when the forearm is extended. It must be kept in mind.

Side view. *Fig.* 307. Front view.

Fracture of the lower extremity of the humerus, with displacement of the lower fragment forwards.

Direct examination by palpation must always be conducted with gentleness ; very often it is rendered difficult by the great amount of swelling which is present. If possible, reduction and fixation should not be attempted until they can be effected under the guidance of two radiographs, showing front and side views respectively. In rare cases the deviation and overlapping may occur in the directions opposite to those just mentioned, and then it is the lower fragment which is tilted forwards and causes the prominence in front (*Fig.* 307).

Reduction, and, still more, the maintenance of the fragments in

position after reduction, is often exceedingly difficult, and the ultimate result very uncertain. A general anæsthetic should always be employed.

Before any attempt at reduction, never omit to examine the pulsations of the radial or ulnar artery, and the cutaneous sensibility and movements of the forearm and hand, to determine the existence or otherwise of any arterial or nervous lesions, and if any are found, to mention the fact and indicate the probable consequences.

Raise the limb, and give the forearm to an assistant; stand behind and apply both hands to the arm, the thumbs resting against the epiphyseal fragment, which they push forwards and downwards, the fingers crossed over the diaphyseal fragment, which is pulled upwards and backwards; while at the same time the assistant pulls on the forearm, first in extension, then in gradually increasing flexion. This is practically the manœuvre already indicated (see *Fig.* 213) for reduction of a dislocation of the elbow backwards.

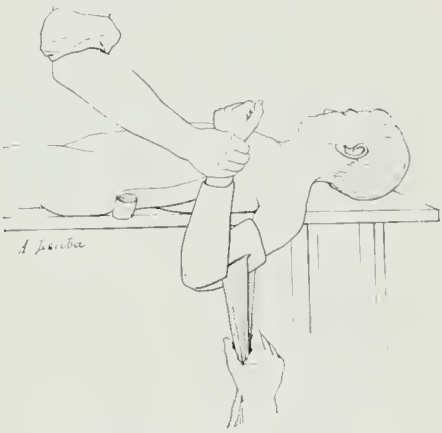


Fig. 308.—Fixation of the arm during the drying of the plaster apparatus (Judet).

When the longitudinal continuity of the bone has been restored (reduction is fairly often indicated by coarse crepitus), do not forget to correct any transverse deformity which may exist; firm pressure exercised over the lateral prominence will restore it to its proper position. Apply the plaster case (see *page* 378), maintaining the traction on the flexed forearm and the countertraction on the reduced diaphyseal fragment while doing so, and until the apparatus is thoroughly dry. The displacement is very liable to recur immediately the retaining hand is removed to allow the plaster to be applied; to overcome this difficulty, the plan recommended by M. Judet will be found very useful:[1] a loop of bandage is placed over the front of the arm at the level of the fracture, and the two ends are carried backwards, one of them through a slit made in the plaster case, and by steady traction on them the fragments are held in position (*Fig.* 308). The elbow is to be fixed—this is a rule of general application in these injuries—**at an acute angle** not at a right angle.

Lastly, the period of immobilization, though necessary when there is considerable overlapping, will be as short as possible; this is a cardinal

[1] Judet, "La fracture sus-condylienne de l'humérus chez l'enfant." *Bulletin médical*, 1905, Nos. 93 & 95.

principle which is particularly applicable to fractures opening into the cavity of the joint.

(*b*). **Isolated Fractures of the Internal or External Condyles** (*Fig.* 309).—Whether it springs from the internal or external border of the

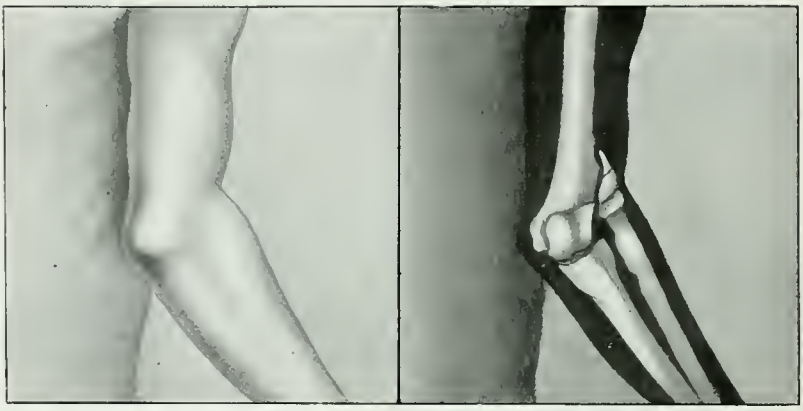


Fig. 309.—Fracture of the external condyle of the humerus.

humerus, the line of fracture is oblique, and terminates in the groove of the trochlea; it detaches a wedge-shaped fragment, the apex of which is supero-internal or supero-external; in a fracture of the external condyle, the fragment includes the epicondyle, the condyle, and the outer rim of the trochlea; and in a fracture of the internal condyle, the epitrochlea and the inner portion of the trochlea.

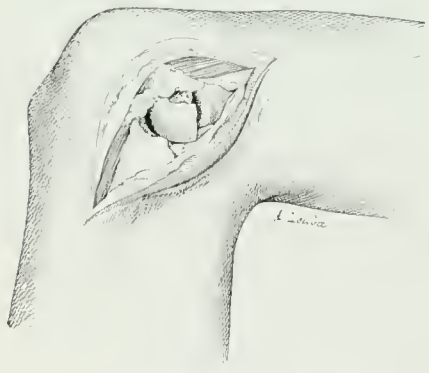


Fig. 310.—Fracture of the external condyle, with rotation.

The fragment usually slips upwards, and tilts backwards and carries the bones of the forearm with it, so causing a lateral deviation of the elbow and appearances which simulate a lateral dislocation or subluxation of the radius or ulna.

However, in such cases the deformity can be very easily reduced, but reproduces itself equally readily as soon as the restraining hand is withdrawn; there is a difference in level between the two lateral prominences, the epicondyle and the epitrochlea, and the mobility of the fractured condyle is easily recognized and crepitus can be obtained. Reduction is

effected by direct pressure on the displaced fragment and by inclination of the forearm to the opposite side, and the attitude is maintained until the plaster apparatus has completely set.

It sometimes happens that the external condyle is torn completely away, and is rotated so that its cartilaginous surface comes to be directed upwards; reduction is then quite impossible, and the best plan is to extirpate the loose fragment at once, by an external lateral incision (*Fig.* 310).

We must also mention the isolated fractures of the epitrochlea and epicondyle, the latter being very uncommon; when the epitrochlea is drawn markedly downwards and forwards, it becomes necessary to suture it in proper position.

(*c*). **Supra- and Intracondyloid Fractures** (*Fig.* 311), **Multiple and Comminuted Fractures of the Elbow.**—The whole region is found enormously swollen, painful and powerless, and to make a diagnosis with any degree of precision, and also for the purpose of properly applying the plaster apparatus, general anæsthesia is practically indispensable.

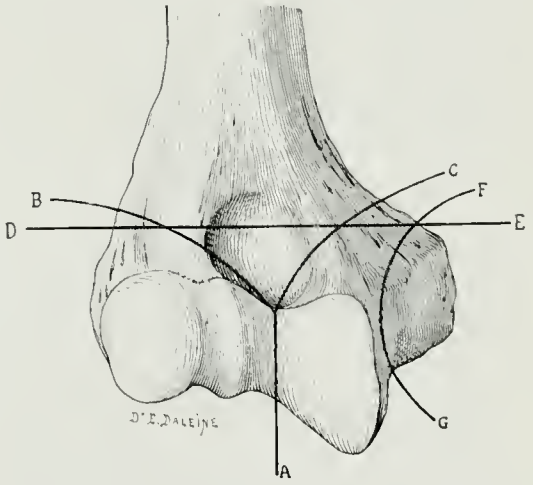


Fig. 311.—Fractures of the lower extremity of the humerus. (Diagram after Kocher). (AB) Fracture of the external condyle. (AC) Fracture of the internal condyle. (DE) Supracondyloid fracture. (FG) Fracture of the epitrochlea. (ABC) Y-shaped fracture.

Make sure that the joint has preserved its movements of flexion and extension, and that there is no mechanical interference with pronation and supination. Place the elbow in a position of moderately acute flexion, the forearm semipronated, and, as before, immobilize the limb in a plaster case.

These articular fractures must only be immobilized for the shortest possible time: early massage and movements, actively pursued, are the most valuable factors in bringing about functional recovery; in cases where there is little or no displacement, they may be sufficient in themselves. The immobilization ought not to be prolonged beyond fifteen to twenty days in adults, or twelve to fifteen days in children.

It is in cases of this kind, and where there is complete dislocation of the lower extremity of the humerus (*Fig.* 312), that open reduction and wiring or pegging of the fragments is most serviceable, when the surrounding conditions are such as to justify one in taking the responsibility. (See later, Open Reduction and Re-union of Fractured Bones.)

Immobilization of the Elbow in a Plaster Apparatus.—The method of procedure is as follows, and the general principles apply equally to the construction of all plaster apparatus.

Fig. 312.—Comminuted intercondyloid fracture.

One requires *plaster-of-Paris*, fine, dry and well sifted; *muslin*, for which, if necessary, ticking or other loose-meshed material may be substituted; *water*, and *bandages*.

Begin by *cutting out the splint.* It must reach up to the deltoid insertion and down to the lower third of the forearm (*Fig.* 313); it ought to envelop two-thirds of the circumference of the limb. As the material shrinks about one-third after being impregnated with the fluid plaster, due allowance must be made for the shrinkage, and the breadth of the upper and lower parts of the piece made equal to the circumferences of the arm and forearm respectively.

Sixteen layers of muslin are required in the splint; two oblique cuts are made, one on either side at the level of the elbow-joint, to allow of subsequent imbrication, and then all the layers are rapidly basted together with a coarse thread.

Prepare the plaster (*Fig.* 314). Pour the dry plaster into a basin half filled with tepid water, distributing it with the fingers until it begins to emerge in little islets above the surface; then only, introduce the hand to stir up the mixture.

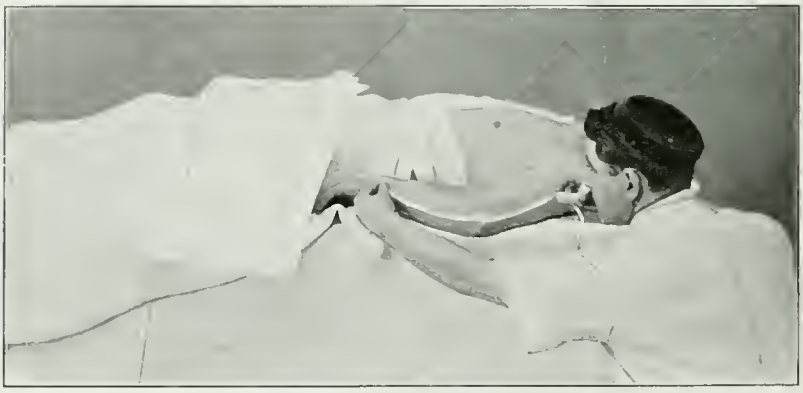


Fig. 313.—Plaster splint for the elbow. Preliminary measurement.

Or again, an equal number of glassfuls of dry plaster and water may be poured into the basin. Whichever method is adopted, the mixture

Fig. 314.—Preparation of the plaster.

Fig. 315.—Plaster splint for the elbow. The shaped material has been impregnated with plaster and the excess is being removed.

ought to be of a uniform creamy consistency. Then soak the prepared muslin in the liquid plaster and work it up well; when it is thoroughly impregnated, let an assistant take it by two of the corners and lift it up slowly, while the surgeon, with his own hands applied flat to the two surfaces, compresses it and removes the excess of plaster (*Fig.* 315). If the liquid plaster has been properly prepared, and if the material has been sufficiently impregnated, it will be unnecessary to dust the surfaces over with dry plaster, as is often done.

Apply the splint. Do not place it directly next the skin, or at least take the precaution of shaving and coating the surface with vaseline.

Fig. 316. Plaster splint for the elbow. Applying the splint.

The best plan is to envelop the limb first with a layer of some thin soft material, such as lint.

See that reduction is maintained and the elbow kept flexed; spread out the splint over the posterior surface of the limb, have the two upper angles held and kept tight by an assistant, while the margins are folded around the limb and the edges of the lateral cuts imbricated to fit the bend of the elbow (*Fig.* 316). It only remains to apply the roller bandages carefully from below upwards, without jerking, without any sudden pressure which might cause the fragments to slip out of place, and then to let the plaster dry.

It is matter of capital importance that the extension and counter-extension should be maintained until the apparatus is thoroughly set,

until it has acquired sufficient solidity to enable it to take up its function of fixing and supporting the limb (*Fig.* 317).

The Nervous Complications which may be associated with or follow these fractures of the lower humeral extremity—particularly in children—must not be forgotten. Most often it is the ulnar nerve which is implicated, less commonly the median or musculospiral. They are seen particularly after a supracondyloid fracture or fracture of the external condyle; they may be *early*, contemporaneous with the injury, and it is therefore always advisable to investigate the sensibility and motor power

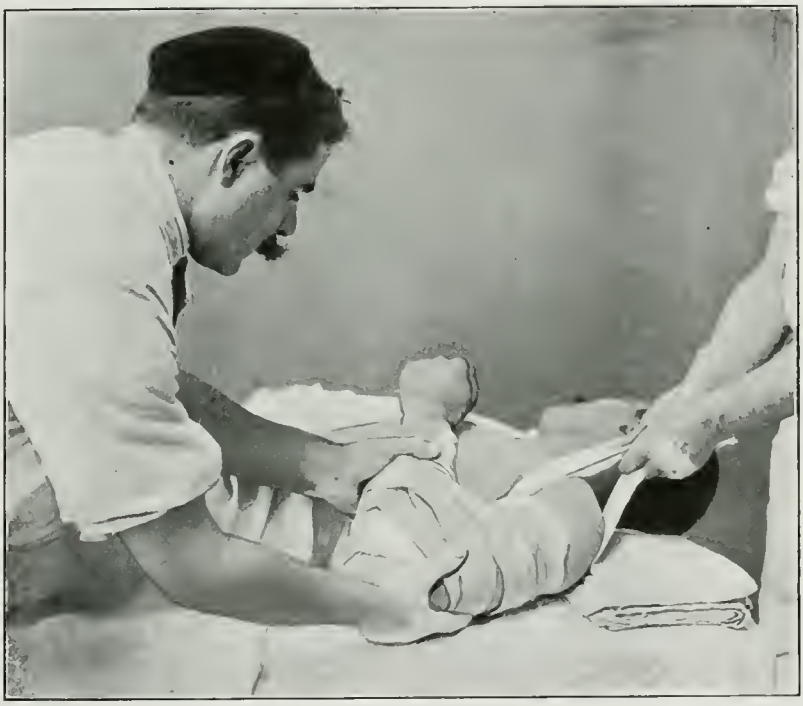


Fig. 317.—Plaster splint for the elbow. Maintaining the reduction until the plaster has thoroughly set. (Note the elbow flexed to an acute angle.)

in the areas of distribution of the three peri-humeral nerves, in the manner already recommended for the musculospiral in cases of fracture of the shaft of the humerus—or *secondary*, appearing some days or even some weeks after the traumatism—or *late*. These late palsies—of the musculospiral in particular—may not become evident until after the lapse of several years, eighteen or even twenty-two years after a fracture of the external condyle of the humerus.[1]

[1] A. Broca et A. Mouchet, "Complications nerveuses des fractures de l'extrémité inférieure de l'humérus." *Revue de chir.*, 10 juin, 1899.

They seem then to be associated with the secondary deviations of the elbow, cubitus valgus, cubitus varus, which follow infantile fractures and irregular development of the epiphyseal cartilages; after a fracture of the external condyle, premature ossification of the outer part of the cartilage fairly often occurs, with angular deviation of the forearm to the same side, the olecranon is approximated to the epitrochlea, and the ulnar nerve is compressed.[1]

Due consideration must be given to the possible development of these later complications, when expressing the prognosis in cases of fracture of the lower end of the humerus, especially in children.

IV.—Fractures of the Olecranon.

We no longer seek to bring the fragments together by this or the other, more or less complicated, fixed apparatus, nor is it necessary to discuss the relative advantages of fixation in extension or flexion: **do not fix the limb at all.**

At the most, if there is some swelling, envelop the flexed elbow with a thin layer of wool and a bandage, or simply with a flannel or crêpe bandage, and keep the forearm in a sling for the first week. Massage will be employed from the beginning, repeated daily and combined with movement exercises, at first passive, then active. Excellent results can be obtained in this way, especially in the cases where the separation is not great and when the fibrous tissues around the olecranon have in part remained untorn.

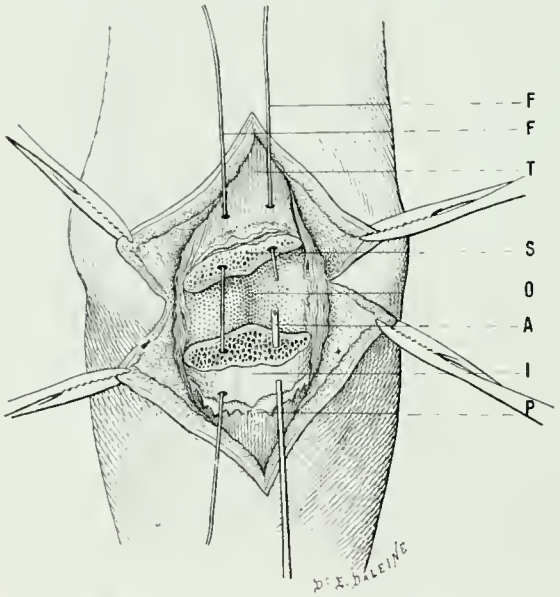


Fig. 318.—Suture of the olecranon. 1st step. The introduction of the wires. (F F), The two longitudinal wires. (T) The tendon of the triceps. (S) Fractured surface. (O) The posterior aspect of the humeral trochlea. (A) Bone drill. (I) Ulnar fragment. (P) Periosteum.

However, if the tricipital fragment is retracted very far, and is very mobile, if there is considerable effusion of blood, and, on the other hand, if the fracture is compound, and

[1] See Savariaud, "Les complications nerveuses des fractures de l'extrémité inférieure de l'humérus chez les enfants." *Arch. gén. de méd.*, 13 janvier, 1903, No. 2, p. 65.

the surgeon feels—giving due regard to the conditions—that he can conscientiously attempt suture, it will give excellent results, with the express reservation, however, that movement is begun very early.

How is this operation to be done?

Suture of the Olecranon.—In the case of a simple fracture, the fragments will be exposed by cutting and turning up a U-shaped flap, or more simply by a transverse incision, which will give sufficient access when the edges are well retracted. It will be well always to place the incision a little above or below the line of fracture, to avoid any subsequent adhesion

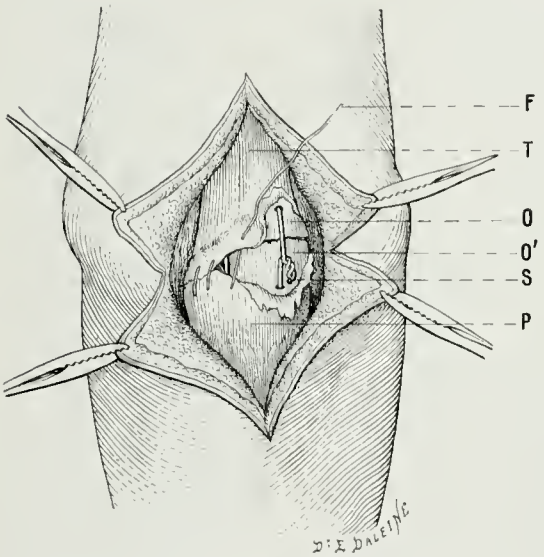


Fig. 319.—Suture of the olecranon. 2nd step. Wires twisted and the ends turned down; periosteal suture. (F) The periosteal continuous suture. (T) Tendon of triceps. (O O') The two fractured surfaces brought together. (S) One of the wires twisted and turned down. (P) Periosteum of ulna.

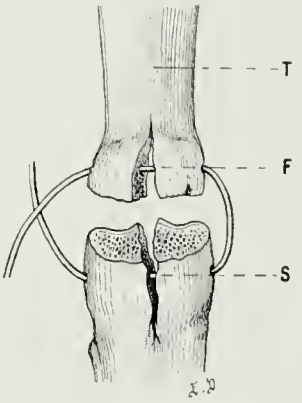


Fig. 320.—Reunion of the olecranon by a transverse suture. (T) Tendon of the triceps. (F) Upper fragment, split vertically. (S) Lower fragment, also split.

between the two. In the case of a compound fracture, the existing wound will be utilized, enlarging it transversely if necessary.

In these cases the hæmorrhagic effusion is almost entirely extra-articular. Carefully cleanse the whole area; excise, if need be, the ragged fragments of the synovial bursa, separate the edges of the fracture, and cleanse in its turn the underlying articular cul-de-sac.

That is the first step. The restoration of the continuity of the fractured process constitutes the second. One or other of the following methods may be employed, according to the type of fracture.

1. **Reunion by two Vertical Sutures.**—With a bone drill—a simple gimlet will do—bore two pairs of holes, exactly facing each other, in the fragments; bore the holes obliquely, making the drill emerge on the

fractured surfaces superficial to and without penetrating the articular cartilage (*Fig.* 318). The two sutures of silver or aluminium-bronze wire are then passed ; the forearm is extended, and the hands of an assistant, grasping the arm, push down the tricipital fragment and hold it accurately adjusted to the distal fragment, while the surgeon twists, in succession, the two pairs of ends. The wires are then cut short about an eighth of an inch from the bone, and pressed down flat against its surface, to be covered in with the periosteum.

The operation is terminated by uniting the edges of the fibro-periosteal tissues by means of a continuous suture of fine catgut, as shown in figure 319 ; and the skin is sutured without drainage.

2. **Reunion by a Single Transverse Suture.**—The two fragments are drilled from side to side, from without inwards : a single wire is passed through both, so that the ends are to the outer and the loop to the inner side (*Fig.* 320) ; the two ends are then twisted together, cut short, and turned down as before. A continuous, fibro-periosteal suture covers in the line of fracture posteriorly.

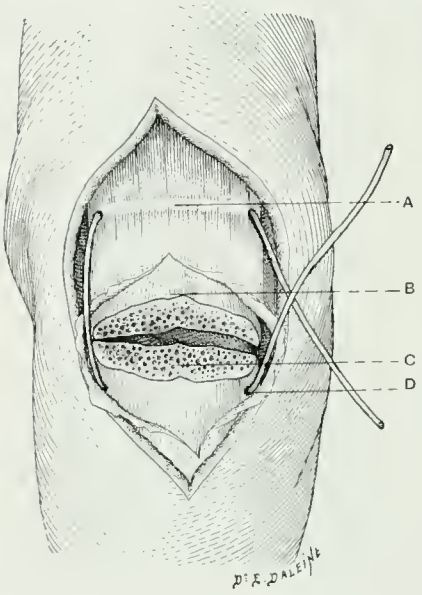


Fig. 321.—Reunion by a transverse suture, passed through the tendon of the triceps. "*Cerclage*" of the olecranon. (A) Wire traversing the tendon close to its superficial surface. (B) The upper fragment of the olecranon. (C) The lower fragment. (D) The wire passed through the lower fragment.

This method, which we have ourselves frequently employed, is also excellent ; it is very useful, particularly in the cases where the upper fragment, sometimes both fragments, is divided by a second vertical or oblique fissure, and the various pieces are so small that there might be some difficulty in uniting them satisfactorily by vertically placed sutures : the transverse wire binds the whole firmly together.

3. **Reunion by a Single Transverse Suture, traversing the Tricipital Tendon.**—This "*hémicerclage*" is a modification of the last method, and is indicated in the cases where the upper fragment is very small, a mere splinter of bone appended to the tendon of the triceps, and in which the lesion is more nearly akin to a tendinous rupture than to a fracture.

In place of trying to pass the wire through the bony fragment, which would simply split under the drill and would subsequently afford no secure hold, it is passed *through the thickness of the tendon* close to its insertion ; below, the other end traverses the olecranon at about a third of an inch

from the line of fracture (*Fig.* 321). On tightening and twisting the wire, the two fragments are brought into good apposition: fibro-periosteal suture; skin suture as before. (See later, for the methods of dealing with ruptured tendons.)

After suture of the olecranon, no plaster apparatus should as a rule be employed; the elbow will simply be enveloped with an ordinary dressing and supported in a sling, and on the fourth day movements of flexion and extension will be commenced.

V.—Fractures of the Bones of the Forearm.

It is necessary to distinguish: 1. *The fractures of both bones*, the fractures of the forearm properly so-called; 2. *The isolated fractures of the ulna*; 3. *The isolated fractures of the radius.*

The fractures of both bones and those of the lower extremity of the radius are by far the most frequent.

Fig. 322.—Fracture of the forearm. Lateral angular deviation of the fragments; very little displacement.

Fig. 323.—Fracture of the forearm. Angular displacement of the fragments.

Fig. 324.—Fracture of the forearm. The upper pair of fragments are displaced to between the lower pair.

1. **Fractures of Both Bones.**—In the very young, the fracture is often incomplete, the bone being simply bent from before backwards, like a green stick, and the fragments not separated. A more or less

well-marked curvature alone indicates the fracture. The deformity is corrected by bending in the opposite direction, and then the forearm is enveloped in a layer of wool and a bandage over which anterior and posterior splints are applied; the splints are only allowed to remain for a few days, and massage is begun at once.

In a complete fracture of both bones with overlapping, reduction and, still more, retention in good position, are far from being easy; too often the fragments are not restored to sufficiently close contact, their extremities

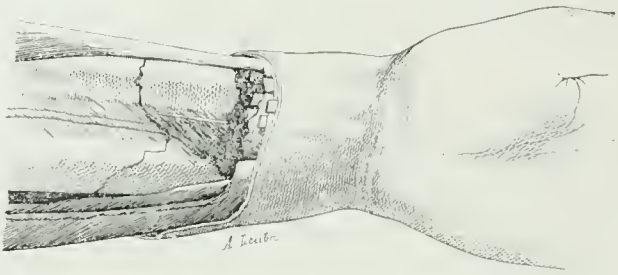


Fig. 325.—Fracture of both bones of the forearm.
When the hand is supinated the fragments lie in good position.

remain embedded in the surrounding masses of muscle tissue, and a false joint results; or again, deviating towards the interosseous space, they become fused together, and the resulting common radio-ulnar callus interferes with the movements of pronation and supination, and renders the forearm more or less useless. The displacement may assume very different forms; *Figs.* 322, 323, 324 represent three fairly common types.

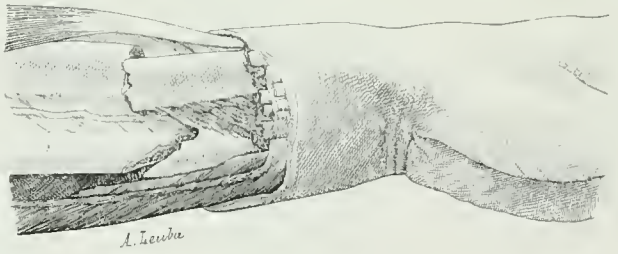


Fig 326.—Fracture of both bones of the forearm.
The least degree of pronation of the hand causes displacement of the fragments.

To correct the displacement, flex the forearm to a right angle, and have good counter-extension applied above the elbow; take hold of the wrist, and first place the hand in complete supination, then exercise longitudinal traction in the axis of the limb, which restores the bones to their normal relationships. If necessary, the adjustment of the fragments may be completed by placing the fingers over the interosseous space, at the upper part of the anterior surface of the forearm, and following it from above downwards.

It is in this position of supination that the fixation apparatus must be applied; *Figs.* 325 and 326 show very well how the slightest degree of pronation tends to displace the fragments. The forearm and the elbow will be immobilized in a plaster splint, extending from the metacarpal region to the lower third of the arm; the inclusion of the wrist and elbow is indispensable, if tilting of the fragments towards the interosseous space is to be avoided. Under the splint, in front and behind, along the position of the interosseous space, it will be well to place a layer of gauze or lint folded into a graduated compress. Lastly, the extension and counter-extension will be carefully maintained (*Fig.* 327), following the practice already indicated, until the plaster has properly set. It is always desirable to control the reduction within the plaster by radiography; the result

Fig. 327.—Extension and counter-extension of the forearm while the plaster is drying.

will often be surprising; but if the bones are found to be out of place, it is always possible to remove the apparatus and complete the reduction. Here, again, the period of immobilization must be reduced to a maximum of two to three weeks; massage and local gymnastics will complete the treatment and will prevent, better than any apparatus, radio-ulnar ankylosis and limitation of the rotary movements of the forearm.

Fracture of both bones occurs at varying levels; when low down it simulates, at first sight, a fracture of the lower end of the radius (*Fig.* 328); it ought to be reduced and fixed in the same way as the latter. Lastly, it may be that the two bones are not broken at the same level, or again, that the fragments of one of the bones (the ulna) remain in contact, and that those of the other bone alone are displaced; in such cases the conditions are much more favourable for perfect restoration of function.

2. **Isolated Fractures of the Ulna.**—It would be more correct to say, fractures of the shaft and of the lower extremity of the ulna, those of the upper extremity (olecranon, coronoid process) having already been considered.

The fractures of the shaft are usually produced by direct violence, and do not overlap; sometimes the lower fragment is moderately displaced forwards and outwards. Massage alone is usually sufficient.

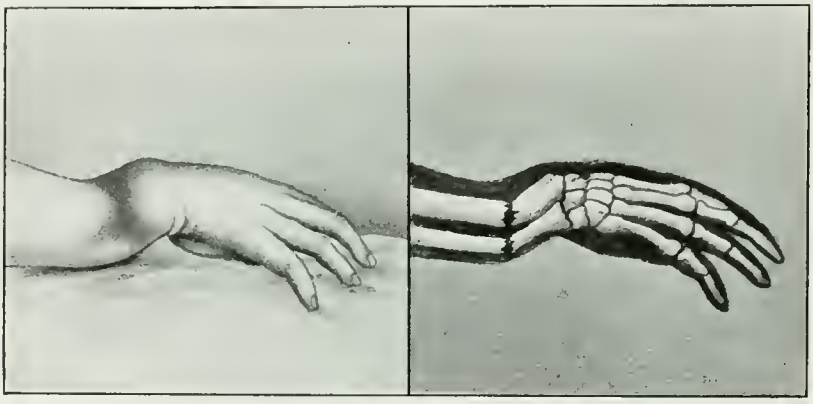


Fig. 328.—Fracture of both bones in the lower part of the arm.

Lower down, attention must be directed to the fracture of the styloid process—very seldom occurring as an isolated lesion—but which often complicates the fractures of the lower end of the radius, and ought always to be looked for in cases of injury to the wrist. Here, again, massage constitutes the sole necessary treatment.

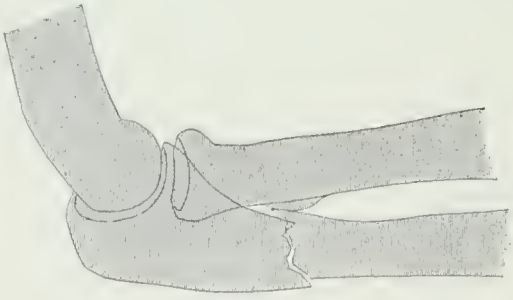


Fig. 329.—Isolated fracture of the upper third of the ulna.

Lastly, one must not overlook the fractures of the upper third of the ulna associated with dislocation of the head of the radius forward. A fracture at this level may, however, occur as an isolated lesion without displacement (*Fig.* 329); the treatment is then exceedingly simple, massage

being all that is necessary. In a case combined with forward dislocation of the head of the radius,[1] the deformity is quite typical (*Fig.* 330); the ulnar displacement must be corrected, and the dislocated head of the radius reduced, and the limb then immobilized for a short time in a position of flexion.

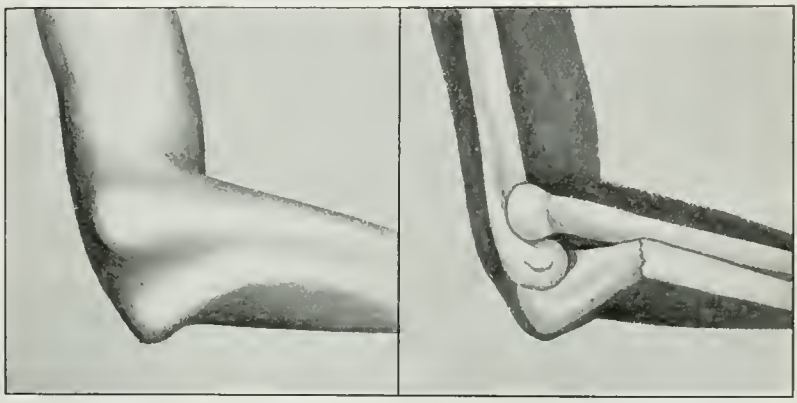


Fig. 330.—Fracture of the upper third of the ulna, with dislocation forwards of the head of the radius.

3. **Isolated Fractures of the Radius.**—Keep the fractures of the head of the radius in mind, particularly the fissured fractures of the cup-shaped upper surface; they are uncommon, and usually associated with other lesions of the elbow; their existence may be suspected when a definite, fixed pain is produced by pressure on the head of the radius, but they can only be recognized by radiography. In children, fractures

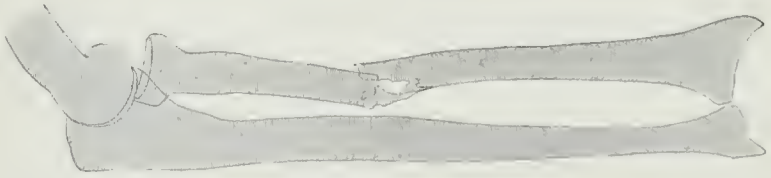


Fig. 331.—Isolated fracture of the shaft of the radius.

of the neck of the bone are fairly common; almost always there is some displacement; the diaphyseal fragment is carried upwards or forwards, and the head of the radius is tilted backwards. The forearm is in a position of semipronation; the movements of flexion and extension at the elbow are practically normal; pronation and, still more, supination,

[1] The head of the radius may be dislocated forwards and outwards, or, exceptionally, backwards.

are painful and limited. On palpation, the forward projection of the lower fragment can be felt ; *the fixed pain at the radial neck* and *the pain on supination* are, in all cases, the best signs (Broca), but here again radiographic verification is always advisable. Massage and movements are commenced forthwith and continued methodically ; when there is very pronounced displacement, resection of the head of the radius may ultimately become necessary.

With regard to **the isolated fractures of the shaft of the radius**, they are usually situated in the middle part ; they are sometimes impacted and indicated externally by an angular deformity (*Fig.* 331) ; sometimes, though the ends are in contact, the fragments are rotated in opposite directions ; in any case, however, the deformity is only moderate, and here again massage is alone indicated.

Here let us draw attention to the enormous masses of callus to which certain subperiosteal fractures in young persons, without deformity and

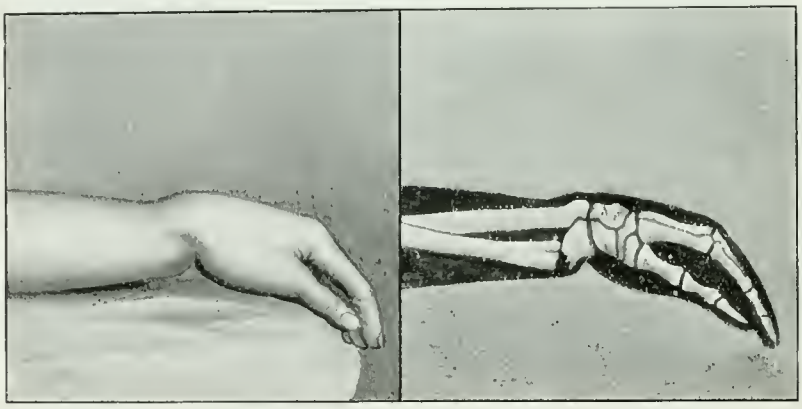


Fig. 332.—Fracture of the lower end of the radius.

unrecognized, sometimes give origin. A medical man was called to see a little girl, who for several weeks had had a small, painless, ovoid tumour at the middle of the left radius, and which was slowly increasing in size ; the little patient was rather pale and thin ; the tumour was of bony hardness. Was it a sarcoma ? On close enquiry, however, a history of a fall on the forearm was obtained. A month and a half later the swelling had entirely disappeared.

Fractures of the Lower Extremity of the Radius.—It is unnecessary to dwell on the signs of the typical fracture (Colles' fracture) : silver-fork deformity of the back of the hand and wrist (*Fig.* 332) ; upward displacement of the styloid process of the radius (*Fig.* 333) ; fixed pain on pressure at about half an inch above the line of the joint (*Fig.* 334) ; the hand is displaced outwards, the styloid process of the ulna prominent,

the wrist rounded; radiography shows the cause of the deformity; the epiphyseal fragment is displaced backwards and fixed in the abnormal position by the impaction of the upper fragment (*Fig.* 335).

Fig. 333.—Fracture of the lower end of the radius: determining the position of the bi-styloid line.

In addition to this well-defined type, it is necessary to consider certain other varieties, somewhat less frequent, but which also require to be known.

Fig. 334.—Fracture of the lower end of the radius: examination of the bone from below upwards.

The deformity may be very slight or absent altogether; this is not very uncommon in women and in old men. The fragments do not become

impacted in old men, the epiphysis simply splits ; as a rule, there is neither fixed deformity nor definitely localized pain, but there is crepitation and abnormal mobility. Deformity is also very often absent in the fractures which happen to motorists (chauffeur's fractures).

The opposite deformity to the " silver fork " is sometimes seen ; in other words, the lower fragment is displaced and rotated forwards.

Separation of the Epiphysis is common amongst boys between the ages of 10 and 15 years ; it is rarely seen in girls ; it may occur as late as the 25th year

The lower radial epiphysis joins with the shaft at from 20 to 22 years in the female, from 20 to 25 years in the male. M. Reclus has even observed an epiphyseal separation, demonstrated by radiography, in a young woman

Fig. 335.—Fracture of the lower end of the radius.

nearly 26 years old.[1] The deformity is much the same as in the fracture, but the upper fragment causes a larger and more definite prominence in front, lateral mobility and coarse crepitus are easily obtained ; the line of separation is situated lower than in the case of the fracture, at about a quarter to a third of an inch from the line of the joint. The exact diagnosis can only be settled by radiography. Lastly, the radial epiphysis may be the seat of **atypical fractures,** comminuted fractures, T-shaped fractures running into the wrist joint, fractures of the styloid process or of the posterior margin of the articular surface.

One must not omit to look for possible complicating lesions, fractures of the styloid process of the ulna, carpal fractures, etc.

[1] Reclus, " Des fractures de l'extrémité inférieure du radius." *Gazette médicale de Paris,* 5 décembre, 1906.

What is to be done? **If there is no deformity, begin massage** at once, nothing more; if, however, the fracture is very mobile and the wrist much swollen, a short period of immobilization might be useful.

When there is a "**silver fork**" **deformity, it must be reduced.**

Fig. 336.—Reduction of a fracture of the lower end of the radius.

The reduction must not be a useless pretence, as is too often the case; it must be effected methodically and completely. The deformity cannot be dissipated by massage nor diminished by lapse of time, and if the necessary preliminary treatment is neglected, the patient will be left not only with a very ugly prominence, but often with very considerable diminution of the functional usefulness of the hand.

To effect reduction, an assistant grasps the lower third of the forearm and holds the limb horizontally, presenting the back of the hand and the wrist to the operator, who, standing in front, places his hands as shown in *Fig.* 336, the fingers below, the thumbs above on the dorsal prominence, and

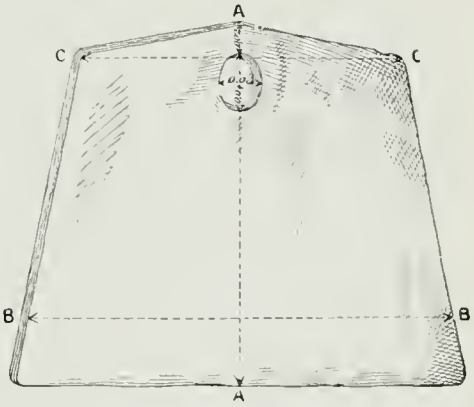


Fig. 337.—Hennequin's plaster apparatus for fracture of the radius. The splint cut out.[1]

[1] The splint, composed of twelve to fifteen layers of coarse muslin, forms an irregular quadrilateral figure, its length (A A) being equal to the distance from the fold of the elbow to the palmar fold which corresponds to the metacarpo-phalangeal articulations; the breadth of the upper part is the circumference of the upper portion of the forearm (B B); the breadth

exercises energetic pressure on the projecting bone, at the same time flexing the hand firmly and inclining it to the ulnar side.

This disimpaction requires a considerable amount of force, and naturally cannot be effected without a good deal of pain, but it can be done very quickly, if the triple manœuvre of *direct pressure*, *flexion*, and *inclination to the ulnar side* is properly executed, and if care is taken to place the thumbs and fingers correctly before the movement is begun.[1]

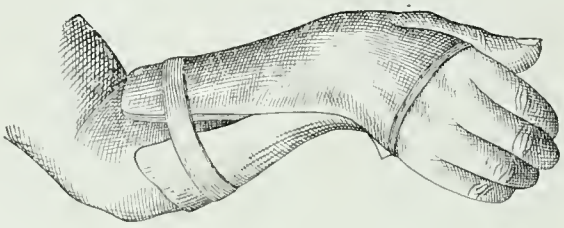


Fig. 338.—Hennequin's plaster splint for the wrist.

In cases with considerable deformity, anæsthesia is advisable.

After the displacement has been corrected, no splints need as a rule be applied, and massage will be begun at once ; however, when the deformity is very marked, and considerable force has been required in effecting reduction, it will be well to fix the limb for a week in a plaster case, prepared and fitted as shown in *Figs.* 337 and 338, and here again, massage will complete the restoration of function.

VI.—Fractures of the Bones of the Hand.

We have already discussed (p. 302) the dislocations and **fractures of the carpus.** The isolated fractures most frequently affect the scaphoid ; but any of the carpal bones may be fractured, particularly the cuneiform, the semilunar, the os magnum, and the unciform. They are rare accidents, and the diagnosis is usually difficult, and can only be made definitely by radiography.

With **fractures of the metacarpus,** if there is any notable deformity or displacement, it must be reduced by traction on the corresponding finger, combined with direct pressure, and the hand be fixed on a flat or moulded splint for eight or ten days ; massage will do the rest.

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of the lower part the circumference of the wrist plus 1¼ inches (C C). At the middle of the lower part of the splint, about an inch from the digital border, an oval opening, measuring 1¾ inches longitudinally, 1¼ inches transversely, and intended for the passage of the thumb, will be made. When it is applied the splint ensheathes the forearm as in figure 338. (Hennequin, "Considérations sur le mécanisme, les symptômes et le traitement des fractures de l'extrémité inférieure du radius." *Revue de chir.*, 1894, pp. 557, 801.)

[1] Naturally, when the deformity is in the opposite direction, lower fragment forwards, the reductory manœuvres will be reversed.

The fracture of the base of the first metacarpal (Bennett's fracture) must be mentioned; the lower margin of the articular surface, which extends like a process below the trapezium, is detached, and the rest of the base of the metacarpal is partially dislocated upwards and backwards. At first sight it simulates a dislocation. Reduction is as a rule easily effected by simple pressure from above downwards, combined with traction on the thumb in extreme extension, but the displacement recurs, and the best plan is to fix the hand in a plaster splint for a fortnight and then to employ massage.

Fractures of the fingers are best treated by simple massage and movements. When situated close to the posterior extremities of the phalanges they may be taken for dislocations; if the displacement is very marked, and there is difficulty in retaining the fragments in position, it is sometimes advisable to fix the finger, flexed over a roll of bandage, for a limited time. The roll of bandage is placed transversely under the flexed finger; a broad strip of diachylon plaster, notched opposite the joints, is applied longitudinally to the back of the finger; at the nail the plaster is divided and the two ends are carried back laterally to cross over the metacarpal (Clamann).

VII.—Fractures of the Pelvis.

Fig. 339.—Attempting to elicit pain by lateral compression in a fracture of the pelvis.

We shall describe briefly: (1) *The partial fractures*: (2) *The extensive fractures*, usually complicated by other osseous and grave visceral lesions; (3) *The typical fracture, the double vertical fracture.*

1. **The Partial Fractures** may implicate the iliac crest, of which a segment of variable size may be detached—the spines, the tuberosity of the

ischium, etc. They are to be recognized by the fixed local pain, discovered on systematic examination of the osseous pelvic girdle ; sometimes, especially when the crest is affected, by abnormal mobility. **Rest in bed** constitutes the only necessary treatment.

2. **The Extensive Fractures** are seen after severe traumatisms, crushing injuries, etc., and very often they are associated with fractures of the lower extremities, of the vertebral column, with grave contusions of the abdomen, rupture of the bladder, etc. ; it is particularly these visceral lesions and shock which demand immediate treatment.

3. **The Double Vertical Fracture,** whatever may be the mechanism of its production (transverse or antero-posterior compression), consists of an *anterior vertical fracture*, involving the horizontal ramus of the pubis and the ascending ramus of the ischium, and a *posterior vertical fracture*, in the immediate vicinity of the sacro-iliac joint, detaching the wing of the sacrum or the posterior part of the ilium.

Fig. 340.—Examination of the ischio-pubic rami in a case of fracture of the pelvis.

An examination must always be made on both sides, front and back ; transverse compression of the pelvis (*Fig.* 339) with the two hands applied broadly to the iliac crests, will, when a fracture is present, produce an acute pain, which is a very valuable sign ; the genito-crural fold (*Fig.* 340) is next carefully explored, by following the bony margin of the obturator foramen with the finger ; behind, the postero-superior iliac spine, the sacro-iliac

synchondrosis, and all the surrounding area, are explored in the same manner. A rectal examination is also advisable.

In moving a patient with a fractured pelvis, all the precautions which we have already detailed in speaking of fractures of the spine are again necessary. (See FRACTURES OF THE VERTEBRAL COLUMN, vol. i., p. 276.) Immobilization of the patient on the back, by means of Bonnet's spinal trough, or some similar apparatus, constitutes practically the whole of the treatment in so far as the fracture itself is concerned; in some cases, where the detached portion of the pelvis is displaced and drawn upwards, continuous extension applied to the thighs may be indicated.

Lastly, the intra-pelvic lesions, especially those of the deep urethra, which are not uncommon, are a source of great difficulties in treatment, and constitute very serious elements in the prognosis. They must always be kept in mind, and looked for at once after every pelvic injury; if found, the treatment will be conducted on the lines already laid down. (See TRAUMATIC RUPTURES OF THE DEEP URETHRA WITH FRACTURE OF THE PELVIS.)

VIII.—FRACTURES OF THE THIGH.

Let us presume that we have to do with a fracture about the middle of the thigh with the common antero-external displacement (*Fig.* 341); the thigh is shortened and everted, and the whole of the lower segment of the limb, the leg, and the foot, rest on their outer surface. The diagnosis is evident, and any elaborate exploratory manœuvres are both useless and harmful.

Move the fractured limb as little as possible; that ought to be the invariable rule, not only to spare the patient pain, but also for the purpose of avoiding periosteal separations, muscular lacerations, and increase in the amount of blood effused between and around the fragments, which may, in certain conditions, seriously aggravate the initial lesions. For the same reasons, the transport of the patient demands the greatest care. (See later, FRACTURES OF THE LEG.)

Have the patient laid on a hard mattress, without bolster or pillows. One assistant places himself opposite the pelvis, and by applying one of his hands on the inner side of the thigh, to the pubis and perineal region, and the other externally over the iliac spine, insures counter-extension; another assistant grasps the foot and the lower third of the leg, and pulls longitudinally in the axis of the limb.

The surgeon stands to the outer side, and encircling the front of the thigh with both hands, by pressure with the thumbs endeavours to adjust the fragments, as they are gradually drawn down towards their natural position.

If the outward angulation of the thigh is very great, the traction should be applied in *moderate abduction*, and should be prolonged, to allow the muscles time to become exhausted, and to yield. In general, reduction

offers no serious difficulties; and, further, it can always be effected under continuous extension. It is always essential, however, to reduce the fracture before applying the apparatus, and to ascertain its complete reducibility by restoring the thigh to its normal length and shape.

The two following points will indicate that satisfactory reduction has been obtained; **the axis of the thigh has recovered its normal direction, and the injured limb is of the same length as its fellow** (the pelvis being straight and the anterior superior iliac spines in the same horizontal line); and when the two limbs are placed side by side, **the upper borders of the two patellas lie in the same transverse line**, the tips of the two internal malleoli exactly correspond, and the soles of the feet lie in the same plane.

Fig. 341. Fracture of the thigh. Overlapping.

Some special manœuvres may be required to effect reduction when the fragments are very oblique and sharp-pointed, and have penetrated into the surrounding muscular layers; the fragments are then fixed by the muscular bands which envelop and are interposed between them. In addition to the traction on the thigh in moderate abduction, it is then necessary to employ various rotary movements, lateral flexion, or circumduction, for the purpose of disengaging the two ends and bringing them into correct apposition. Of course, in such cases, general anæsthesia is of the very greatest help.

With regard to treatment after reduction, surgical opinion is settled, and it is quite unnecessary to describe all the old forms of apparatus which have from time to time been employed. Even immobilization in plaster loses the greater part of its advantages, and in those enormous plaster gutters, veritable stoneworks, which envelop the whole limb, and encase the pelvis, the fragments again become displaced, and though there may be no actual overlapping, the primary external angular deviation at least will recur. Apart altogether from the difficulties associated with their

application, and the discomfort which they cause, these great plaster cases are deceptive, and give merely the appearance of well-maintained reduction.

It is **continuous extension** which must be employed, by means of **Tillaux's** and **Bardenheuer's** or **Hennequin's methods.**

Tillaux's and Bardenheuer's Apparatus.—Cut a strip of adhesive plaster, 2½ inches wide, and sufficiently long to be applied to both sides of the limb, on the outside up to the great trochanter, on the inner side to just below the genito-crural fold, a loop being left below the sole; without raising or disturbing the limb, apply the plaster smoothly to the skin, taking care to avoid folds and wrinkles. In place of one broad strip of plaster, five or six narrower parallel bands, each about an inch wide, may be used and applied one by one, each succeeding strip partially overlapping the preceding one.

Over the longitudinal bands, a series of circular bands, each about an inch in width, are applied to the leg and thigh; these circular bands are slipped transversely under the limb and then folded over the anterior surface; they are applied from below upwards, commencing just above the ankle, and each succeeding band imbricates the preceding one. The knee is left exposed. For the protection of the skin, a fold of gauze, eight layers thick and an inch in width, is laid along the crest of the tibia, and gauze pads are placed over the malleoli, before the circular imbricating strips of plaster are affixed.

Be deliberate, and see that each part is properly applied. It then only remains to fit **the cord, the pulley,** and **the weight** (*Fig.* 342).

Between the subplantar loop of the extension plaster and the sole, place transversely a flat piece of wood, in breadth equal to the distance between the two malleoli, and carrying a ring screwed into its centre; to this ring the cord will be attached.

If there is no suitable pulley at hand—it is, as a rule, not difficult to obtain one in most households—a cylindrical wooden rod, such as a piece of a broom handle, may be employed instead. If the patient is lying on an iron bedstead, the piece of wood can be fastened horizontally to two of the bars, a little above the level of the mattress, so that the traction may be exerted in a *slightly ascending direction*; if the bedstead is an ordinary large wooden one, a hole will be bored in the footpiece at the proper height, and its margins rounded off, and through the hole the cord will be passed.

The weight will be attached to the free end of the cord. What weight? Seven, eight, ten pounds, fifteen pounds at the most as a general rule; it will be well, however, not to restrict oneself to any absolute limit. The weight must necessarily vary according to the patient's muscular development, the type of fracture, and the difficulties associated with "longitudinal" reduction; and it is now recognized that loads, formerly considered excessive, are quite well borne and cause no injury, if the extension bands are carried considerably above the level of the fracture, the bony prominences carefully protected in the way we have described, the knee slightly flexed over a small cushion, and the apparatus constantly supervised.

When properly applied, this apparatus corrects the longitudinal displacement, if not at once, at least after the lapse of a few days, when the muscles have yielded. It will be sufficient in itself in certain transverse fractures with comparatively little lateral deviation of the fragments; it is, however, a very different matter in oblique fractures; and too often, even though continuity appears to have been re-established and the limb has recovered its proper length, when the extension is finally removed, it will be found that a huge mass of callus, similar to that shown in *Fig. 343*, is present, and that there is no direct union between the two fragments; these large masses of callus are very liable to bend and to cause secondary shortening when the weight of the body comes to be put on the limb.

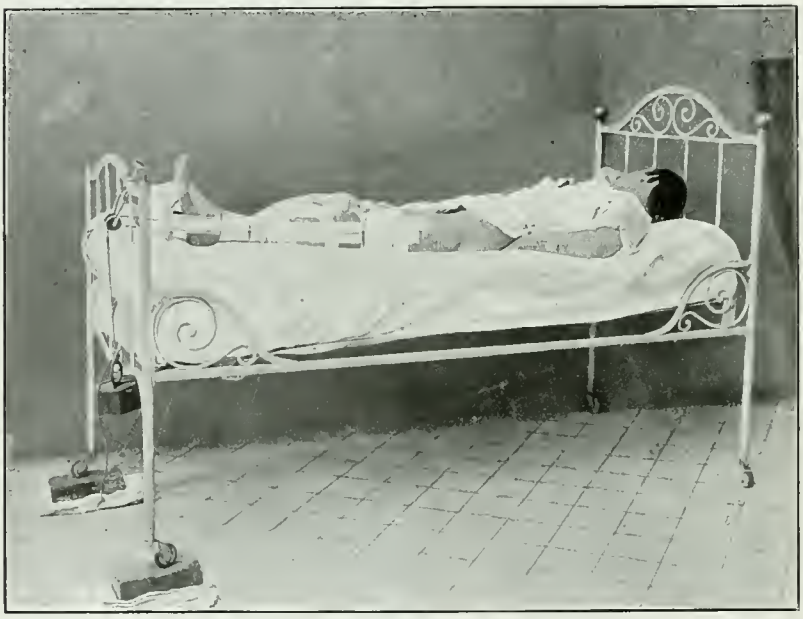

Fig. 342.—Fracture of the thigh. Tillaux's apparatus.

Undoubtedly, if the longitudinal traction is applied in abduction or adduction, it may also to some extent influence the lateral deviations. The action is, however, always incomplete and uncertain; and when the treatment by continuous extension, of which we are speaking, is employed, it is advisable to follow Bardenheuer's technique.

The longitudinal extension does not correct the *lateral*, *angular*, or *rotary* displacements; to reduce them, secondary traction loops are required.

These loops are simply bands of adhesive plaster about two inches wide. Let us presume that we have to deal with a case in which it is necessary to restore the outwardly deviated upper femoral fragment to its proper position. The band is placed around the thigh, outside the extension

apparatus, already installed, with its centre over the summit of the bony projection ; on the inner side of, and not far from, the thigh, the two ends of the band are stitched together, or united by one or two strong pins ; within the loop thus formed a wooden stirrup is placed, with a cord attached, and the cord is passed through the centre of the line of junction of the two ends of the band ; to the end of the cord the weight is hung.

If, as in the case quoted, transverse traction is required, the cord is simply led over the side of the bed, and the weight hangs free ; no pulley is necessary.

If upward traction is needed, to raise a depressed fragment, a similar loop of adhesive plaster is used ; now, however, the middle of the loop is placed under the limb, the ends are stitched or pinned together just above it, and from the loop the cord is carried vertically upwards, and at sufficient height above the bed must be led over a pulley.

But how is the pulley to be fitted in a suitable position? It is a simple matter, and no special apparatus is required ; with one or two screw pulleys, and some pieces of board, a perfectly efficient system of upward traction can be produced. The patient is lying on an ordinary wooden bed ; make a framework over the bed, out of two boards placed vertically, and a third—in length equal to the breadth of the bed—placed horizontally ; the two vertical pieces of the frame will be fixed to the wooden side-pieces of the bed, opposite the point at which the vertical traction is to be exerted ; all that then remains to be done is to screw a pulley into the cross-piece, and to pass the cord over it. If necessary, a second pulley can be screwed into one of the vertical supports, and the cord led from one pulley to the other. If the upward traction must be exerted somewhat obliquely towards the patient's head or feet, the supporting pieces of the frame will also be set obliquely at a suitable angle to the sides of the bed.

Fig. 343.—Vicious union after fracture of the thigh ; persistence of overlapping enormous mass of callus.

In a case of fracture at the middle of the thigh with the ordinary deformity (overlapping, upper fragment displaced outwards, lower fragment inwards), it would be necessary to provide : (1) Longitudinal extension with a sufficient weight ; (2) Transverse traction, towards the sound side,

on the extremity of the upper fragment; (3) Transverse traction towards the injured side on the upper end of the lower fragment; (4) Transverse traction on the pelvis towards the injured side.

The outward pelvic traction is complementary to the inward traction exercised on the lower extremity of the upper fragment; it is, indeed, always useful to add to the reducing traction applied to the displaced extremity of a fragment, counter-traction in the opposite direction, applied to the other extremity; the two forces acting in opposite directions are complementary and mutually helpful.

We need not dwell further on the details of the method; in general practice, and without special experience of the method, one cannot expect to obtain the mathematically exact reductions of which M. Bardenheuer speaks;[1] further, the correct application of the traction loops implies a very exact knowledge of all the displacements which are present; and a preliminary study of two good radiographs, taken from the front and side

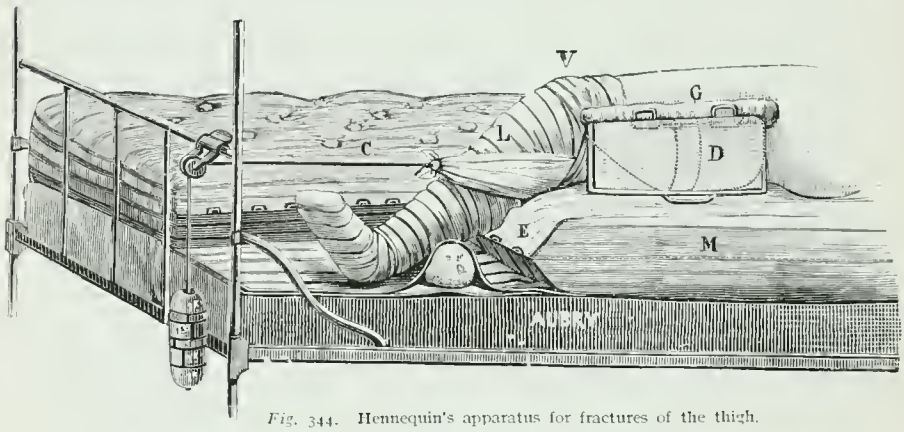

Fig. 344. Hennequin's apparatus for fractures of the thigh.

respectively, is therefore particularly useful. Radiography ought also to be employed to verify the position of the fragments after the apparatus has been applied. But even when initial radiographic examination and subsequent control are not available, it is always possible to recognize the principal deviations, and to correct them by means of the lateral tractions which have just been described, and which should always be employed in addition to the longitudinal extension.

In very young children, vertical extension with the aid of a suitable frame gives very good results, prevents soiling of the apparatus, and facilitates the necessary attention to cleanliness.

Hennequin's Apparatus.—This possesses the great advantage of allowing the patient to be placed in the sitting position in bed. The

[1] See BARDENHEUER and GRAESSNER, *Die Technik der Extensions-verbände bei der Behandlung der Frakturen und Luxationen der Extremitäten.* 3 Aufl., Stuttgart, 1907.

extension is exercised on the lower part of the thigh, with the knee flexed at an angle of about 40°.

I cannot do better than quote Hennequin's own minute instructions, which should be closely followed.

Preparing the Mattress.—"The patient is placed in a convenient position near the side of the bed. The under sheet is turned up, and the margin of the mattress is opened from its lower angle to a hand's-breadth below a transverse line corresponding to the middle of the popliteal fold of the injured limb. The stuffing is then removed from the opened-up part of the mattress for a breadth of ten or twelve inches, and that which lies just beyond the transverse line is pushed upwards, so as to make the part of the mattress on which the thigh rests more resistant. If it seems desirable, the stuffing removed from the lower part of the mattress can be also used to pack into the portion under the thigh, for the purpose of giving the requisite degree of flexion to the knee. The coverings of the mattress are fastened together with strong safety-pins at the limits of the area from which the packing has been removed. The result is *an empty quadrilateral space destined to receive the flexed leg* (*Fig.* 344).

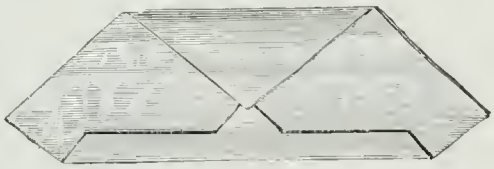

Fig. 345.—Hennequin's apparatus. Manner of folding the towel.

"An assistant standing at the foot of the bed, with one hand grasping the heel and the other the metatarsus, gently raises the injured limb, and maintaining moderate traction, holds it over the empty space.

"**Application of a well-padded Compressive Bandage.**—A layer of wool, about four inches in thickness, is arranged regularly round the foot, the leg, and the lower fourth of the thigh, and fixed in position with two firm roller bandages, one applied from below upwards, the other from above downwards. A moistened muslin bandage is applied over the foot and lower part of the leg, completely to cover in the wool. This compressive envelope (*Fig.* 344), when properly applied, has a thickness of about two inches, and follows the contour of the enclosed limb.

"**Fitting the Extension Bands.**—The compressive bandage having been applied, the middle of a folded towel (*Fig.* 345) is placed over the front of the patella. The two ends are carried backwards, one on either side of the knee, and cross over the postero-superior part of the calf; then, changing sides after the crossing, they pass obliquely forwards round the upper part of the leg, and are knotted together in front of the mid-line of

the limb at the junction of the upper and middle thirds of the tibia (*Fig.* 344). The arrangement is that of a figure-of-eight, the upper loop of which encircles the lower end of the femur, without transmitting any traction to it; and the lower loop surrounds the upper part of the leg.

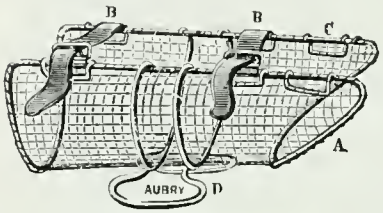

Fig. 346.—Hennequin's apparatus. The gutter for the thigh.

"**Immobilization of the Thigh in a Gutter Splint. Completion of the Apparatus.**—A gutter splint, suitably padded, either of metal (*Fig.* 346), or improvised with plaster, or wicker-work, etc., and of appropriate length, is carefully slipped under the slightly-raised thigh; the leg is flexed slowly to 40°, until the heel rests on the springs, or on the under mattress, if there is one.

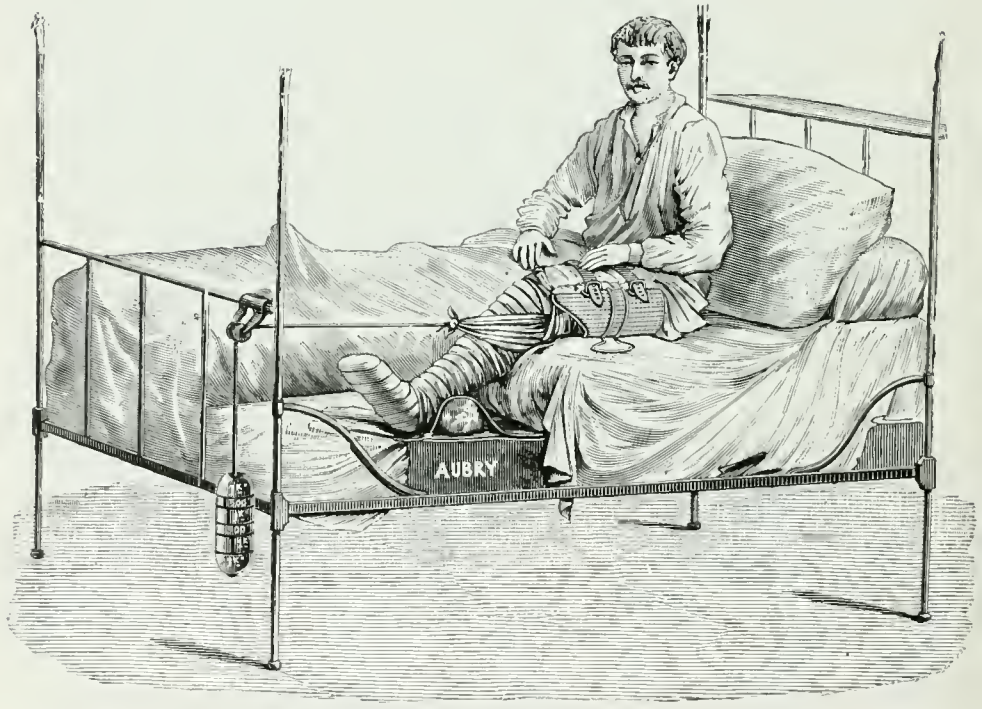

Fig. 347.—Hennequin's apparatus. The patient seated in bed.

"One of the ends of the cord is attached by a simple running knot to the lower loop of the extension band: *to the inner side of the loop, if the thigh is rotated inwards; to the outer side, when the rotation is outwards; directly over the knot, when there is no rotation.* The cord is led over a pulley

at the foot of the bed, and a weight of from five to seven pounds attached to the other end.

"The thigh is fixed in the splint by a number of straps; before they are fastened, however, some tightly rolled pieces of wool, varying in size according to the space to be filled, and overlapping the margins of the splint, are arranged around the thigh between it and the inner surface of the splint; these pads of wool are packed in firmly at the prominence formed by the projecting fragments, loosely on the opposite side of the limb. The thigh is kept well pressed down into the gutter, and a thick layer of wool is placed over its anterior surface, and over the wool a wooden splint is placed longitudinally, and the whole firmly bound together by tightening and buckling the straps.

"**The patient can now sit up and remain seated.** If the heel becomes painful, a pad of wool will be arranged under the tendo Achillis. Every second day 2 lb. will be added to the initial weight, until the total amounts to 9 lb. in adolescents and women, 11 lb. in males of average muscular development, and 12 or 13 lb. in exceptionally powerful men (*Fig.* 347)."

The position of the limb must be verified from time to time, the due maintenance of reduction ascertained and, if necessary, the padding within the gutter splint altered, and the straps retightened. **Constant supervision is absolutely necessary.** I have seen some very bad cases of vicious union after treatment with Hennequin's apparatus which, though properly applied at first, had not been adequately looked to afterwards.

FRACTURES OF THE UPPER END OF THE FEMUR.

The most important of these are the **fractures of the neck**; they are a source of frequent mistakes, and it will be well to recapitulate briefly the principal signs: the loss of power, *the impossibility of raising the heel; the rotation of the limb outwards, fixed in case of extracapsular fracture, reducible in intracapsular fractures; the shortening*, always fairly obvious in extracapsular fractures; *the elevation of the great trochanter above Nélaton's line* (*Fig.* 348),[1] and *the broadening of the great trochanter*, in the same type of fracture. As to crepitus, owing to impaction of the fragments, it is comparatively seldom detected; it is most often associated with intracapsular fracture.

One must not forget the incomplete fractures of the neck, which render themselves evident only by a slight amount of bending, and by a little shortening or rotation outwards, in which the patient is able to raise his heel from the bed, and even to walk. They are often confused with simple contusions of the hip; and, if possible, a diagnosis of contusion, pure and simple, should never be accepted without radiographic verification.

[1] The line which joins the antero-superior iliac spine to the tuberosity of the ischium; in the normal state, with the thigh semi-flexed, the tip of the great trochanter just touches this ilio-ischial line. The trochanter extends for a variable distance above the line in some fractures of the neck of the femur, and particularly in the backward dislocations at the hip.

Whatever the variety may be—admitting that it may be recognized—and excluding the cases with very marked shortening and deformity, fractures of the neck, in old people, ought to be treated by **massage and movement,** which will permit the confinement to bed, with its attendant dangers, to be reduced to the minimum ; and will give all the functional restoration possible.

If shortening and outward rotation are considerable, **continuous extension** will be employed at first, for ten or twenty days, the foot having previously been brought into the proper line.

Fig. 348.—Examination of the hip. Seeking Nélaton's line.

In similar cases, in younger adults, reduction should be effected, at least in so far as it is permitted by the degree of impaction.

The patient will be anæsthetized, and counter-extension being applied to the pelvis, energetic and prolonged traction will be exercised *in the long axis of the thigh*, and the limb at the same time *rotated inwards* ; then, continuous extension, with the knee flexed to an angle of 40°, will be applied by means of Hennequin's method and apparatus, but without the gutter splint for the thigh.

FRACTURES OF THE LOWER END OF THE FEMUR.

In **the transverse supracondyloid fractures,** the displacement is sometimes limited, and reduction easy ; a plaster gutter splint, extending from mid-thigh to mid-leg, for the first week, and massage immediately afterwards, constitute the best means of treatment.

At other times, in cases of **oblique supracondyloid fractures,** the deformity is considerable ; the lower fragment is tilted backwards into the popliteal space (*Fig.* 349) ; and its upper extremity forms a very marked prominence, which is sometimes a source of serious danger to the vessels ;[1] or, again, it may be the upper fragment which is displaced, downward and forward to the patella, and perforates the quadriceps, or even the suprapatellar synovial pouch (see *Fig.* 350). Reduction then becomes a task of primary necessity, and often of considerable difficulty. Bend the knee to a right angle, firmly grasp the two sides of the articulation and the condyles, and pull in the axis of the femur, combining the traction with some lateral movements for the purpose of disengaging the fragment. If needful, have the traction exercised by an assistant, and with the thumbs push the tip of the lower fragment downwards and forwards, the tip of the upper fragment upwards and backwards.

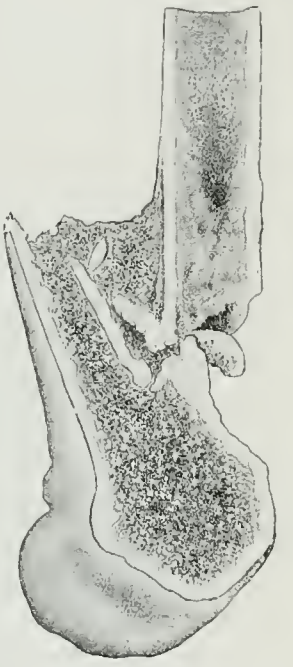

Fig. 349.—Supracondyloid fracture of the femur. Usual displacement of the lower fragment (tilted backwards).

Immobilize the limb in semiflexion ; Hennequin's apparatus is again the best.

If reduction is very difficult, and cannot be effected completely, it will be advantageous to apply provisional continuous extension by means of bands of adhesive plaster (see above, TILLAUX'S APPARATUS) for some days : the contracted muscles will gradually relax, and it will then be possible to complete the adjustment of the fragments and fit the final apparatus.

When the upper fragment is implanted in the quadriceps, and all attempts at disengagement fail, open reduction becomes necessary.

Separation of the Lower Femoral Epiphysis, which occurs in young people, is transverse, and is situated at a slightly lower level than the corresponding supracondyloid fracture ; the epiphysis is displaced forwards, or to the side. Reduction is often difficult ; a good plan is to have the knee strongly flexed, while at the same time with both hands the fragments are pushed in opposite directions, and an attempt made to adjust the fractured surfaces. Once reduction is obtained, continuous extension will be applied forthwith.

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[1] As MM. Hennequin and Loewy have so strongly insisted, it is absolutely necessary in these low-seated fractures of the thigh that the limb should be fixed at once, before the patient is moved ; it will be enveloped in a thick layer of wool from the foot to the groin, and bandaged : outside the bandage, inner and outer splints, extending the full length of the limb, will be applied and securely fixed. (HENNEQUIN et LOEWY, *Les fractures des os longs, leur traitement pratique,* 1904.)

Open operation is only indicated in certain cases of complete irreducibility and considerable deformity, with dangerous tension of the skin or compression of the popliteal vessels.

Vascular lesions, complicating separations of the lower epiphysis, and supracondyloid fractures of the femur, may at times necessitate immediate operative measures. Two possible conditions must be distinguished :

(*a*). **The Fracture is compound** ; there is a wound of variable size in the popliteal space, and from it blood is flowing profusely. As soon as the patient has been conveyed to a suitable place, the whole area will be

Fig. 350.—Supracondyloid fracture of the femur ; displacement forwards of the upper fragment.

thoroughly prepared, the wound enlarged, the lacerated vessels sought for and secured, the displaced fragment reduced, after resection of its projecting extremity, and the operation terminated by suturing the wound or, better, by packing it lightly with gauze.

Should the contents of the space—artery, vein, and nerve—be found completely ruptured and retracted upwards and downwards, and the popliteal region extensively lacerated, amputation through the thigh will be necessary.

(*b*). **There is no external wound,** but an enormous swelling develops rapidly in the popliteal space and extends to the calf and the posterior aspect of the thigh, and presents all the signs of a traumatic

aneurysm. In such a case, the rational procedure consists in opening up the space, and looking for and ligating the ends of the torn vessel; amputation will only be performed as a last resource. In some cases the injury to the vessels is not indicated by any undue hæmorrhagic effusion, but by the rapid development of signs of gangrene; it is then advisable to follow the line of treatment described later on (see SUBCUTANEOUS RUPTURES OF ARTERIES), and to refrain from immediate amputation.

Combined Supra- and Inter-condyloid fractures (*Fig.* 351).—These lesions are associated with extensive hæmarthrosis, and seriously compromise the ultimate mobility of the knee. The wisest plan appears to us to be as follows: give ether or chloroform, puncture the joint, and aspirate the effused blood. Then reduce the fracture, and fit a posterior plaster gutter, with the knee extended, or, in the cases where the lower fragment shows a marked tendency to tilt backwards into the

Fig. 351. Supra- and inter-condyloid fracture.

Fig. 352.—Fracture of the external condyle.

popliteal space, with the knee moderately flexed; do not keep the limb fixed for more than ten or fifteen days, and trust to massage for the rest of the treatment.

The same practice will be followed in the unicondylar fractures (*Fig.* 352); the bony wedge will be restored to position, and the limb immobilized in a large plaster gutter. Open reduction and direct fixation of the fragments will often be required in this class of injuries. (See OPEN REDUCTION AND REUNION OF FRACTURED BONES.)

IX.—Fractures of the Patella.

All fixation apparatus, and all those ingenious bandages, of which even the enumeration nowadays is useless, may be definitely put aside; **no method which involves prolonged immobilization of the knee should be employed.** That point is settled, and there need be no illusion with regard to it.

Massage or suture are, at the present day, the only two methods of treating fractures of the patella.

Massage gives excellent results, particularly in fractures with only moderate separation, and when the lateral aponeurotic expansions are intact.

If for any reasons (age of the patient, refusal of operation, lack of necessary equipment, or the absence of conditions which would render operation justifiable) suture is impracticable, then massage, properly performed and continued for a sufficient length of time,[1] will give good results, even in cases with wide separation; as a rule, the massage should be begun at once, care being taken to keep the limb at rest, and moderately compressed with a flannel bandage in the intervals between the sittings. When there is much effusion into the joint, it will be well to apply careful compression with a well-padded bandage, and to keep the limb on a double inclined plane for a few days. Removal of the effused blood by aspiration—when it can be done aseptically—is also good practice. At the end of four or five days, at the outside, massage will be begun, and regularly pursued; begin with circular compressions over the whole of the peripheral portion of the limb,[2] then pass on to more energetic pressure to the sides of the patella and the lateral aspects of the articulation. Movements are limited at first to slight degrees of flexion, and are steadily, but very slowly, increased, without ever "forcing" the limb; as a rule, by the fifteenth to the twentieth day the patient can be allowed to get up, and to walk; but the massage and passive movements must be continued for several weeks more.

Direct reunion of the fragments, followed by early mobilization, is, however, the method of choice which should always be adopted when possible. Here, of course, as with the olecranon, when the fracture is compound there can be no doubt as to the correct line of treatment.

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[1] See M. Lucas-Championnière's book, *Traitement des fractures par le massage et la mobilization*, 1895—"I consider," writes M. Championnière, "that if a good ultimate result is to be obtained by massage in cases of fracture of the patella, the treatment must be continued for a considerable time. I wish to remark, that however long this time may be, it is always shorter than the period required to get even a very moderate result by means of apparatus. For this reason, I have decided, in all cases where suture has not been performed, to give the patients the benefits of massage." (*Loc. cit.*, p. 501.)

[2] Lucas-Championniere, *Loc. cit.*

Mark out a cutaneous flap with the convexity downwards, which, when dissected up, exposes the front of the patella and the site of fracture. Remove the blood and clots which fill the prepatellar bursa ; separate the two fragments, and cleanse the joint cavity with gauze swabs.

This first step is of capital importance, and for that reason all methods of subcutaneous suture ought to be absolutely put aside ; the operation must include : first, **the evacuation of the knee joint** ; second, **the reuniting of the fragments of the patella.**

Once the first step is properly completed, proceed to the suture. Have the fragments steadied, and with the bone drill (see later, OPERATIVE REUNION OF FRACTURED BONES) bore two holes in each of them at about $\frac{1}{2}$ inch from the line of fracture.

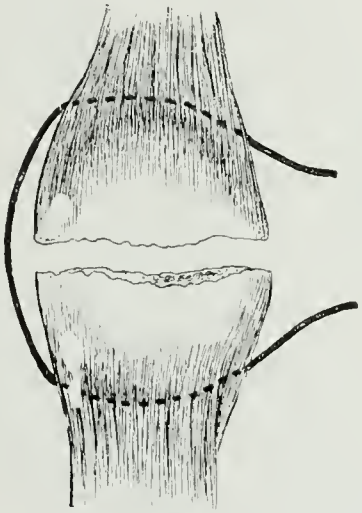


Fig. 353.—Cerclage of the patella. The wire traversing the tendon and the ligament. (Diagrammatic).

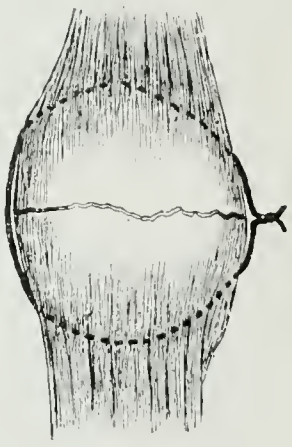


Fig. 354.—Cerclage of the patella. The two fragments reunited ; the wire tightened and twisted. (Diagrammatic).

Hold the drill a little obliquely, so that it emerges on the fractured surface in front of the articular cartilage. It is always better for the ultimate functional activity of the joint that the wires should not enter its cavity, and that they should cause no friction there. With a good awl it is quite easy to bore the holes, if the fragments are pressed against the condyles and steadied between the fingers.

Silver or aluminium-bronze wire, at least 1 millimetre (about 18 W.G.) in thickness is required. Before tightening the wires and twisting the ends, the two bone surfaces to be placed in contact are carefully cleansed with gauze, and then accurately adjusted and held by the fingers of an assistant ; the twisted ends are cut short, turned down, and the periosteum sutured over them.

Quite as good a result can be obtained by encircling the patella with a

heavy silver or bronze wire, that is, by the method of "*cerclage.*" The technique, which is very simple and requires no special instruments, is as follows:

The patella is freely exposed, the joint opened, emptied, and cleansed, as described above. Cerclage, like suture, is an "open" method; and arthrotomy is an essential preliminary step.

I presume that the fragments are of unequal size, the most common condition. Through the thickness of the tendon of the quadriceps, quite close to its insertion, pass a large Reverdin needle, an aneurysm needle, the perforated end of a drill, or any suitable metal rod bent into a hook at the end, from without inwards; and with it draw through, from within outwards, one of the ends of the wire. Repeat the manœuvre at the apex of the patella, and pass the second end of the wire through the patellar ligament (*Fig.* 353 and *Plate VIII*).

Approximate the two fragments, and make sure that they are accurately adjusted; carefully encircle their inner borders with the loop of the wire, then steadily tighten the two ends, and twist them together on the outer side (*Fig.* 354).

If the patella is properly encircled, if the wire passes through the centres of the quadriceps tendon and the patellar ligament, if it is adjusted accurately to the inner and outer borders of the patella, the reunion will be perfectly firm, and the fragments thus bound together will form a solid block.[1]

The edges of the fibro-periosteal layers are then united over the line of fracture by a continuous suture or interrupted sutures of catgut, and the operation terminated in the usual manner.

Cerclage is indicated particularly:

1. When the patella is fractured *very close either to its tip or base*, and the lesser fragment is so small that it would be sure to split if an attempt were made to drill it (*Fig.* 355).

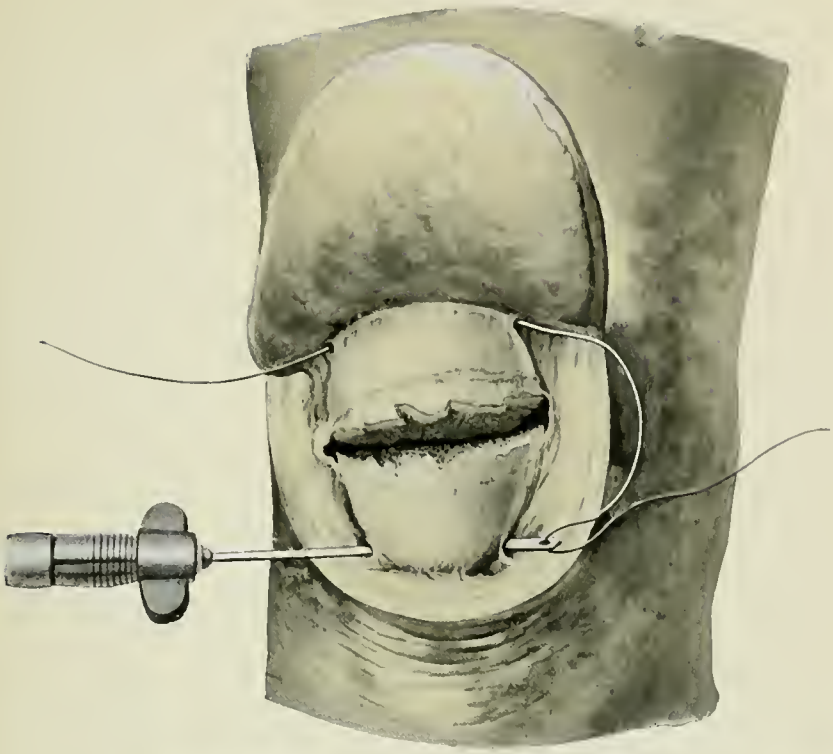
Case 26.—One of our patients, a vigorous cyclist, about 60 years of age, had, in a fall from the machine, fractured his patella so close to the insertion of the quadriceps tendon, that the condition might have been taken for a tearing away of the tendon rather than a fracture; the upper fragment measured scarcely a third of an inch in vertical extent.

The patella was encircled, mobilization was begun on the twelfth day, and on the twenty-fifth the patient could walk with ease; recovery was as perfect as it could be, and the patient has resumed the use of his bicycle.

One might also in such a case employ the method of "hemicerclage" recommended by M. Quénu, and pass the wire transversely through the

[1] M. Quénu has proposed to pass the wire transversely through the two bony fragments at a little more than a fifth of an inch from the line of fracture, and to close the loop on the outer side by twisting the two ends. (Fracture de la rotule; de la suture transversale de la rotule et de l'hémi-cerclage. *Bull. Soc. chir.*, 24 février, 1903, p. 242.)

Plate VIII.—**Cerclage of the patella.** In the upper figure the wire has been passed through the tendon and brought back from within outwards through the ligament. In the lower figure, the two ends of the wire are twisted, the fragments of the patella being accurately coapted.



SUTURE OF THE PATELLA

large patellar fragment on the one hand, and through the tendon or ligament on the other.

Case 27.—In a man, 48 years of age, the patella was fractured quite close to its base, and the upper fragment was not more than a third of an inch in vertical extent. I bored a hole from without inwards, in the thickness of the lower fragment, about a third of an inch from the plane of fracture, and through it I passed an aluminium-bronze wire, which was then brought back from within outwards through the quadriceps tendon. The fragments were adjusted, and the ends of the wire twisted. On the eighteenth day the patient was allowed up, and by the twenty-eighth day he could walk very well.

Fig. 355.—Fracture of the patella close to the base.

2. When the patella is broken into *several irregular fragments*, in cases of comminuted fracture produced by direct violence. Suture is very difficult in such a case; but by cerclage the various pieces of the patella are drawn together, and bound into a solid, regular block; care must be exercised, by raising or depressing the different fragments as may be necessary, to render the anterior patellar surface perfectly regular.

Lastly, in all varieties of fracture of the patella, cerclage, if properly performed, appears to us to be well worthy of recommendation, because of its simplicity and the firm reunion which it gives; it is, above all, a method for use in urgent cases, and is within the powers of those even who are not very familiar with the technique of bone operations.

Whatever the method employed, after cerclage as after suture, the treatment is the same.

After a carefully-bandaged aseptic dressing, a posterior plaster gutter will be applied, extending from the middle of the leg to the middle of the thigh. The limb will be kept in the gutter for *ten days only*. The future functional value of the knee depends on two things: **the mechanical character of the operative reunion of the fractured bone; the earliness of mobilization.** Therefore, do not hesitate to dispense altogether with the plaster apparatus by the tenth day, or the twelfth at the latest, and, after having removed the dressing and the sutures, to begin systematic massage and movements.

X.—Fractures of the Leg.

It must be admitted that these fractures, though so common, are amongst the worst treated, and also amongst those which present the greatest difficulties in systematic treatment and in complete morphological and functional repair.

In this region, these two terms, i.e. "morphological" and "functional," are complementary; *a deformed callus is a weak callus*, and causes very serious impairment of function. **Exact adjustment of the fragments, correct alignment of the limb, good position of the foot**: these

Fig. 356.—Reduction of a fracture of the leg.

are essential for a good ultimate result; "approximately complete" reduction is not sufficient; any irregularity will inevitably express itself by more or less disability and symptoms of varying gravity.

These principles must not be neglected, even in the apparently simplest fractures, with no, or very little, displacement, and in which the treatment promises to be perfectly easy. Reduction will only have been properly effected, and the immobilization can only be considered to be satisfactory, when, after due verification, it is certain:

1. That **the crest of the tibia forms an absolutely continuous** line, without irregularity or depression; and that **the line, when**

prolonged downwards, ends in the first intermetatarsal space; and, further, that the inner surface of the tibia is perfectly smooth and continuous in its entire extent, and presents neither prominence nor abnormal curvature at the site of fracture.

2. That the foot is at right angles to the leg, and the anterior superior iliac spine, the inner border of the patella, and the inner surface of the great toe are in the same straight line (*Fig.* 356).

FRACTURES OF THE SHAFTS OF THE BONES OF THE LEG

(Fractures of the Leg properly so called).

Immediate reduction and immediate immobilization: this is the rule. However, if the limb is much swollen, it is a good plan first of all to envelop it in a thick layer of wool, and to bandage it firmly with a crêpe or flannel bandage, and to fix it temporarily with two side splints applied over the bandage (*Fig.* 357); this temporary apparatus is left in place for

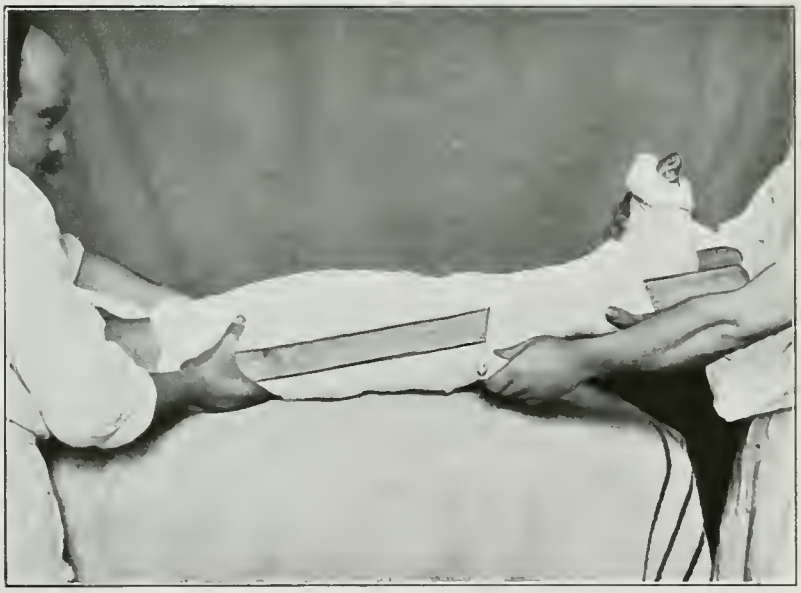


Fig. 357.—Temporary immobilization of a fractured leg.

forty-eight hours. It is also to be recommended in cases where it is necessary to move the patient before applying the final apparatus.

The difficulties associated with reduction and immobilization vary according to the type of fracture.

1. **Transverse, or nearly Transverse Fractures, without Overlapping.**—These are due to direct violence as a rule. The tibia

and fibula are broken at almost the same level; mobility is definite, and very extensive; the leg can be bent laterally, or from behind forwards; but the fragments move one on the other only in the transverse plane of the limb, and the fractured surfaces remain in contact. Simple traction on the foot, with a little local pressure, is sufficient to re-establish the proper connection, which can be maintained without trouble.

The task is, therefore, easy; and with some care an excellent terminal result is assured.

Remember, however, that *the upper tibial fragment always tends to project inwards*; even in cases where reduction had been thought to be perfect, sometimes when the fixation apparatus comes to be removed, a prominent mass of callus is found on the inner side of the leg, forming an ugly, irregular, and painful bony projection.

Fig. 358.—Plaster gutter for the leg. Preliminary measurement.

Therefore, always endeavour to obtain exact reduction, taking care to press in the upper tibial fragment, and to maintain it in position until the plaster case is thoroughly dry.

Plaster apparatus, applied in the way we are going to describe, and applied immediately, provides the most convenient means of treating this group of fractures, and also (see later) certain oblique fractures (almost always, however, as a compulsory procedure, rarely as a method of choice), supramalleolar fractures, and Dupuytren's fracture.

How then are we to make a good plaster case for the leg? We may employ a gutter cut out in one piece (Hergott's gutter), or Maisonneuve's splints; the result will be identical in either case: **a sheath, enveloping two-thirds of the circumference of the limb, and extending from the root of the toes to the lower fourth of the thigh.**

The Gutter.—This is, in my opinion, the easier of the two to apply when alone.

First of all make the pattern ; measure the limb from the toes to mid-thigh, carrying the tape under the sole and heel and up the back of the leg ; mark out the measurement on a large sheet of paper. Take the circumference of the limb at the ankle, at mid-leg, at the knee, and at the thigh ; carry these measurements to the sheet of paper, and lay them out transversely at the proper levels across the vertical line ; join the ends of the lines by longitudinal pencil marks. Having thus traced the outline of the pattern, it is cut out ; and from it the gutter, consisting of sixteen thicknesses of muslin, is cut in its turn.

Fig. 359.—Plaster gutter for the leg. Marking the outline of the gutter.

Some prefer another plan. The whole piece of material, consisting of sixteen thicknesses, is spread out under the sound limb, which serves as the model ; it is slipped upwards till its upper border is opposite the lower third of the thigh ; then turning it up against the sole of the foot, the distal border is marked out at the level of the toes, and the excess cut away (*Fig.* 358). Then the lateral borders are raised and placed in contact with the limb, and its contours rapidly marked out (*Fig.* 359).

To avoid ridges opposite the malleoli, two lateral incisions are made obliquely towards the point of the heel between the plantar and leg portions of the material ; the two resulting angles will be overlapped, as in *Figure* 360.

The Splints. Two are required: **a posterior splint,** going from the toes to the lower third of the thigh; and **a stirrup splint,** the central portion of which is placed under the sole, and the ends carried up the sides of the limb to the same height as the posterior splint (*Fig.* 361).

The splints, like the gutter, consist of sixteen thicknesses of muslin; their borders

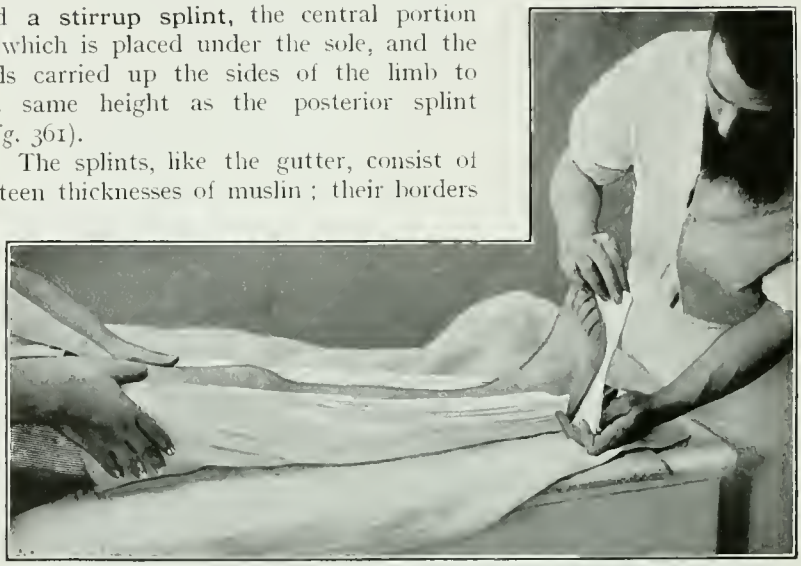


Fig. 360.—Plaster gutter for the leg.
The gutter is cut out; note the oblique cuts at the side of the heel for covering the malleoli.

Fig. 361.—Plaster posterior splint and stirrup splint. Preliminary measurement.

are straight and parallel, and are not cut to the contours of the limb,

and in breadth each is made equal to a third of the circumference at the middle of the leg.

The posterior splint is applied first, and carefully adjusted to the sole of the foot ; the heel, and the calf, and the two upper angles are held, and kept taut by an assistant ; the double side splint is then applied, with its central portion under the sole, and the two ends, being carried up the sides of the limb, complete the gutter (*Fig.* 362). It is, in fact, a gutter in three pieces.

The gutter proper is first spread out under the limb, which is slightly raised, and well steadied at the knee and foot ; care is taken that the upper border of the apparatus extends upwards to the proper height, and that the lateral incisions correspond exactly to the two sides of the heel.

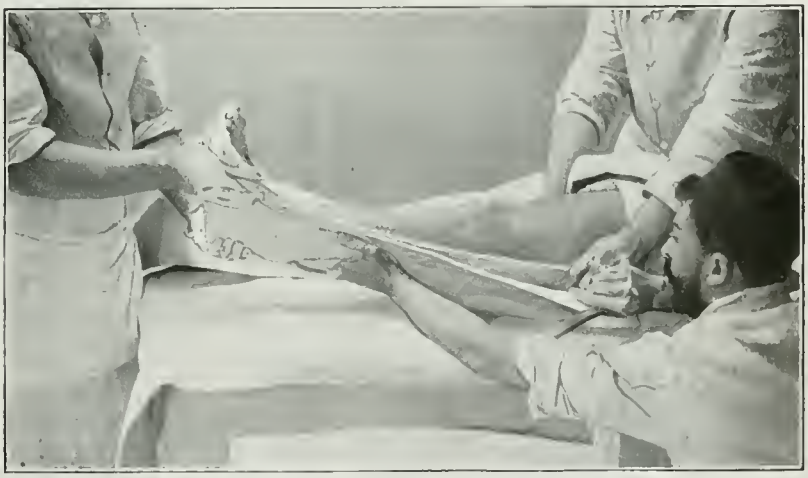


Fig. 362.—Maisonneuve's splints. Fitting the stirrup splint.

Then the limb is lowered on to the gutter, and the borders are folded round the foot, the edges of the lateral incisions overlapped, so that the apparatus fits closely around the ankle ; and the limb being again raised, and the gutter kept tight by traction on its upper angles, the fixation bandages are applied from below upwards (*Fig.* 363).

It is absolutely essential that the limb should be steadily held and reduction maintained while the apparatus is being applied, and until it is completely set ; it is useless to devote a great deal of care to adjusting the fragments, and then to allow them to become displaced anew during the application of the plaster. The limb is not fixed until the plaster case has become firm and hard ; this fact certainly seems sufficiently obvious, but it is so often neglected that it is necessary to emphasise it.

The limb is only properly held when the foot is at right angles with the leg, firmly grasped with both hands, the one under the heel, the other

Fig. 363.—Plaster gutter for the leg. The gutter is applied. Fixing it with a roller bandage.

over the metatarsal region (*Fig.* 364), and when counter-extension is exercised at the knee by another pair of hands encircling the tibial tuberosities.

Fig. 364.—Plaster apparatus for the leg. Maintenance of reduction till drying is complete.

On the following day the roller bandages will be removed, the position of the fragments and the correctness of reduction once more verified, and

then, by means of two or three ties, placed above and below the knee and at the ankle, the gutter will be again fixed to the limb, and eversion of its borders prevented.

But responsibility does not end with the application of the plaster case ; *the treatment of fractures is not limited to some mechanical procedure, executed in a more or less satisfactory fashion, and then dismissed from the mind.*

The fractures must be followed up, a constant watch kept over the apparatus, and, should it seem necessary (if, for instance, after the subsidence of the swelling any defect or irregularity appears), there should be no hesitation in removing and renewing the fixation apparatus.

Do not forget that the ultimate result depends less on the duration of immobilization than on good primary reduction and subsequent maintenance of the fragments in correct position.

Incomplete reduction necessarily involves the absence of broad contact between the fractured surfaces, and, in consequence, slow bony union. Exact coaptation greatly hastens the welding of the fragments together ; it permits of the period of immobilization being reduced to the minimum, without fear of secondary deviations and curvatures.

Fig. 365. Oblique fracture of the leg.

Exact reduction, immediate immobilization, and early massage are the three fundamental and interdependent points in the treatment of those fractures with considerable displacement to which massage cannot be applied from the outset.

The revelations of radiography do not invalidate these sound practical rules ; the X-rays have certainly demonstrated (we had previously had some personal reasons for a little doubt) that even under the most favourable circumstances exact reduction was rarely obtained, and therefore perfect uniformity of the callus was not a condition necessary for functional recovery. Fairly often some degree of deformity remains, but seems in no way to impair the usefulness of the limb.

It is therefore evident that absolute coaptation is difficult, and is seldom obtained, and that it is not indispensable ; but, nevertheless, the morphological result remains as the best guarantee of the functional result.

2. **Oblique Fractures.**—It is in these cases that reduction and, still more, the maintenance of reduction, often constitute one of the most troublesome tasks which falls to the lot of the surgeon.

Here is a leg, fractured at about the middle, shortened and twisted; the foot is rotated outwards, and lies on its outer side; under the skin on the inner side of the leg the sharp-pointed upper fragment of the tibia forms a very marked projection. The line of fracture runs downwards, forwards, and inwards (*Fig.* 365), sometimes in the opposite direction; but it is always very oblique, the overlapping very extensive, and reduction difficult and unstable.

If the surgeon contents himself with reduction which is not quite complete, and hastily fixes the leg, still a little deformed, in a plaster splint, he is inviting a bad result; the apparent reduction is not maintained,

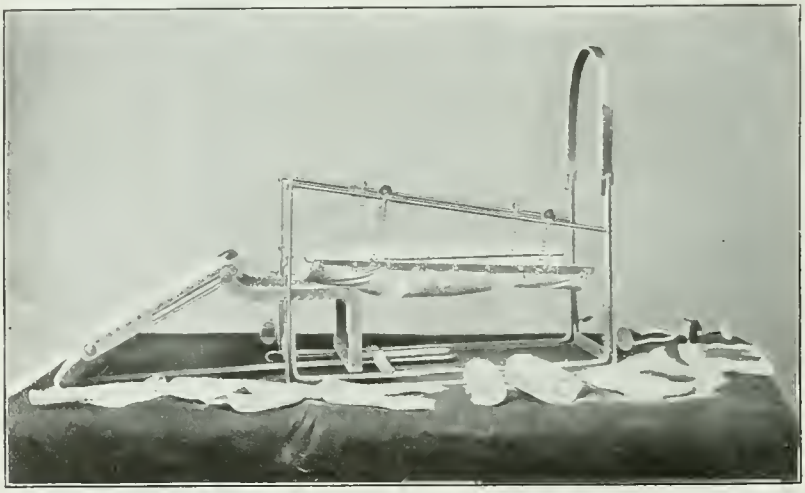


Fig. 366.—Hennequin's apparatus for oblique fractures of the leg. On the table: the stirrup-band, the plaster bandages (rolled), and the two pads.

displacement speedily recurs, and after forty, fifty, or sixty days, the limb is still mobile, bent inwards, and curved forwards; months will elapse before union is complete, and, in the end, lameness and disability will still remain.

The responsibility associated with such a case is very heavy, and **it should be recognized that the treatment of an oblique fracture of the leg is quite as important a matter as many emergency operations.**

In our opinion, the question of treatment may be summed up in a few words: the best method of reduction is by **continuous extension with the leg flexed.** We shall describe first **Hennequin's,** then **Heitz-Boyer's apparatus,** and the various steps in their application; and, afterwards, we shall see how they may be replaced without departing from the principles on which their construction is based.

Figure 366 shows the different parts of Hennequin's apparatus; it consists of *two hammocks* hung from metal rods, which form the framework of a sort of quadrangular box without walls.

The *thigh hammock* is formed of a U-shaped frame, to which a tightly stretched sheet of calico is laced; it is connected with the rest of the apparatus: (*a*) By a double rack arrangement, bent at a right angle, the ends of which engage in slots cut in the side pieces of the U-shaped frame; (*b*) By a flat perforated metal band jointed to the convexity of the frame, and which slides in a groove in the base of the apparatus. It can be fixed at any desired point by a pin which engages in the perforations. By these arrangements it is possible to bring the thigh-piece nearer to, or to remove

Fig. 367.—Hennequin's apparatus. The application of the plaster shoe.

it from, the leg-piece, and to vary its angle of inclination,—in a word, to adapt it to the length of any adult thigh.

The leg hammock consists of three broad separate bands buttoning to two splints suspended by chains, which again are attached to four pulleys, free to move on two inclined polished rods. This hammock is, in fact, a carriage running on rails, set at such a sufficient slope that as soon as any weight is placed upon it the carriage begins to move spontaneously. The hammock may be shortened by unfastening one or two of the eyelets of the upper band on each side from the splints; further, one or other of the bands may be temporarily detached for the purpose of dressing a wound, without disturbing the limb or releasing the traction.

The base of the apparatus is formed of two bands on each side, placed one over the other; the lower one can be moved vertically, and serves to adjust the plane of the bed, and so to insure the transverse horizontality of the inclined plane represented by the rods on which the pulleys run.[1]

The application of the apparatus consists:—(1) *In fixing a stirrup-band around the malleoli by means of a plaster shoe to serve as a traction loop*; (2) *In encasing the leg in a plaster gutter*, for the purpose of preventing lateral displacement of the fragments, and maintaining the foot in the proper direction (the gutter is independent of the plaster shoe); (3) In placing the limb in the two hammocks, and providing *continuous extension*.

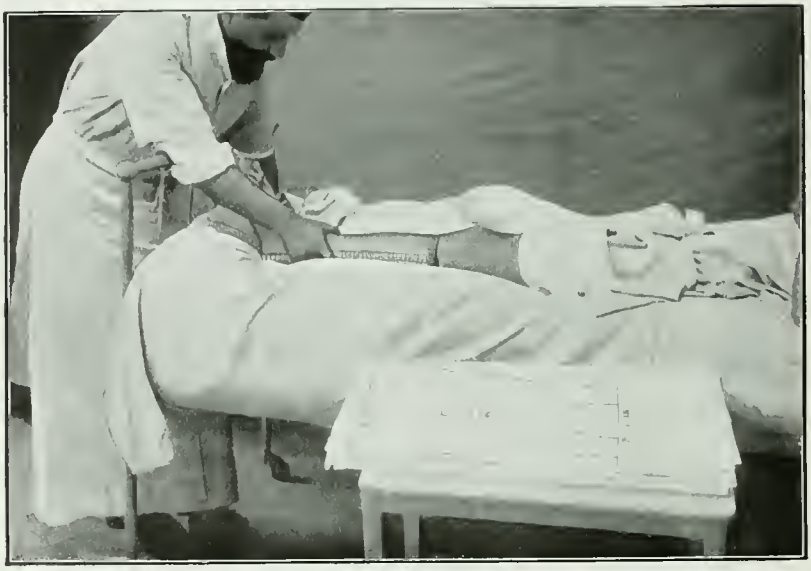


Fig. 368.—Hennequin's apparatus. Measurement of the leg for the pattern of the leg gutter.

1*st step*.—Make two small pads, each about 4 inches long and 3 inches wide, out of twenty or thirty thicknesses of gauze, or several layers of lint or flannel.

Apply these transversely, *one over the front of the ankle, the other behind the tendo Achillis, and the postero-superior part of the heel.* They are fixed in position by plaster bandages, and serve to take the pressure off the places on which most of the traction falls.

A first plaster bandage, 4 inches wide and 4 yards long, is applied from the roots of the toes to the bases of the malleoli; the latter level marks the upper limit of the shoe, and should not be exceeded; the

[1] Hennequin, *Société de chirurgie*, 24 juin, 1896.

stirrup-band is then placed in position, and fixed by a second plaster bandage about 3 yards in length.

The *stirrup* is a double band of canvas, 16 inches long and 2 inches broad. The median loop being held a couple of inches below the heel in the axis of the malleoli, the two ends on either side are knotted together opposite the tips of the malleoli, then the two anterior ends are crossed in front of the ankle over the anterior pad, and the two posterior ends over the pad which protects the tendo Achillis. The application of the second plaster bandage is then continued ; it secures the four ends of the stirrup, and completes the traction shoe (*Fig.* 367).

This plaster shoe is only, and ought only, to be a means of exerting traction, and if made according to the instructions just given, it may be used for continuous extension of the leg, even when the complete apparatus is not obtainable, and it is necessary to improvise something to take its place. (See later.)

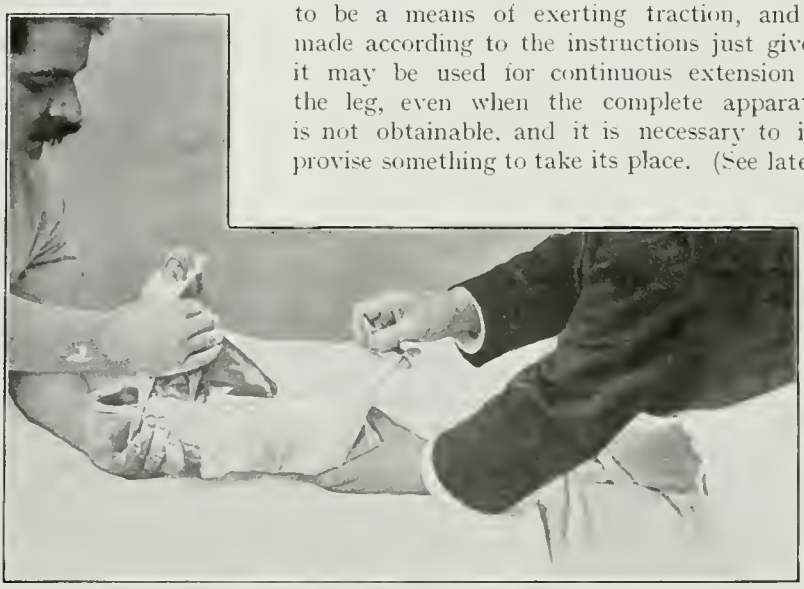


Fig. 369.—Hennequin's apparatus. Application of the leg gutter (a sheet of impermeable tissue separates it from the plaster shoe).

The shoe ought, therefore, to be quite independent of, and must remain isolated from, the gutter for the leg.

2nd step.—The object of this step is, as we have said, to prevent lateral deviation of the fragments, and to preserve the correct alignment of the leg.

Measure the distance from the middle of the popliteal space to the sole (*Fig.* 368) ; this will be the length. Measure the circumference of the leg at the upper part of the calf, and at the base of the malleoli ; these will be the breadths at the upper and lower extremities. With these three measurements the gutter can be outlined and cut.

The lower border is cut out to a depth of 5 inches, and is so transformed into two long tongues which, when afterwards applied to the sides of the foot, will serve as lateral supports.

Envelop the plaster shoe with a sheet of impermeable material (jaconet, oiled silk, or oiled paper), extending well beyond its upper border ; by the interposition of this layer, the shoe and the gutter are prevented from adhering ; and once the plaster is quite dry, the impermeable layer can be extracted, and a free space will then be left between the two portions of the plaster apparatus.

After this precaution has been taken, apply the gutter (*Fig.* 369), while an assistant, holding the foot at right angles, exercises vigorous traction ; the two tongues, which bound the notch in the lower border, are adjusted along the malleoli, and to the sides of the foot, over the shoe. Then mould and fix the gutter to the leg by means of a roller bandage, and have the foot held until the plaster has set.

Fig. 370.—Hennequin's apparatus. Adjusting the position of the thigh hammock.

3rd step.—When everything is dry, remove the bandages and the sheet of impermeable material, *make sure that the gutter and shoe are perfectly free and not adherent*, then fit the continuous extension.

Place the limb in the two hammocks, and incline the femoral hammock sufficiently to allow the leg to lie horizontally (*Fig.* 370). Fix the pulley at the foot of the bed, and attach the cord which supports the weight to the traction loop. The cord is attached to the middle of the loop, if the lower fragment lies in the proper direction ; but if any deviation still persists, inwards or outwards, oblique traction will be more efficacious, and the cord will therefore be attached somewhat internal or external to the exact middle of the loop.

A weight of 5 lb. will be sufficient at the outset; one pound will be added every second day, till the total is 8 lb. in recent cases, 9 or 10 lb.

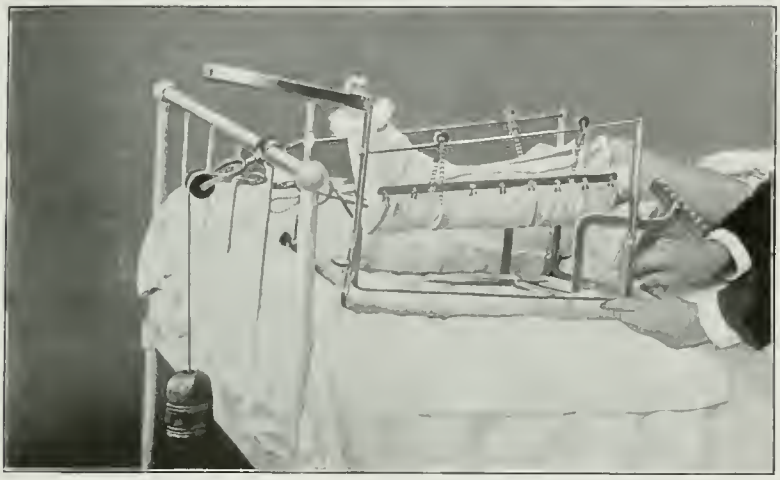


Fig. 371.—Hennequin's apparatus. Raising one of the sides of the apparatus to insure its horizontality

in old fractures. Tolerance being greater during the day than at night,

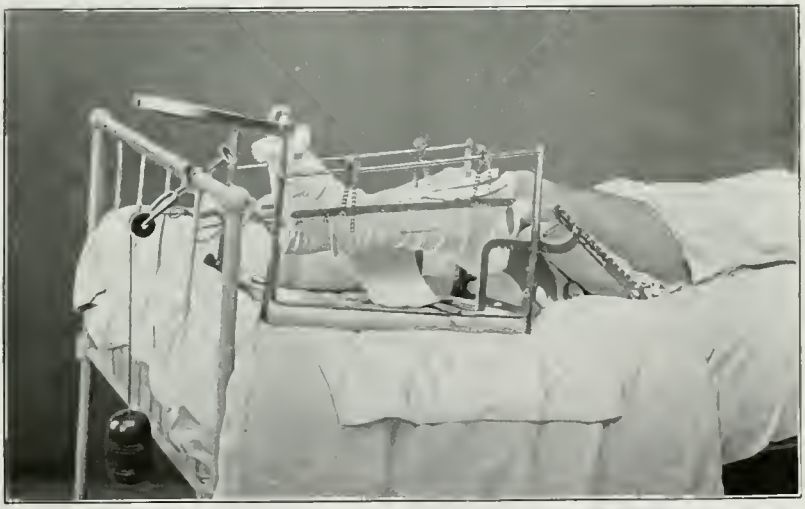


Fig. 372.—Hennequin's apparatus applied. One of the leg-supporting bands unfastened, and a window cut in the gutter, for the dressing of a wound.

it is advisable, when the total weight exceeds 8 lb., to remove the excess towards the evening, and to replace it in the morning.[1]

[1] HENNEQUIN, *Loc. cit.*

Lastly, if the plane of the bed is not quite horizontal, the deviation is corrected by adjusting one of the sides of the apparatus, as shown in *Fig.* 371.

This is Hennequin's apparatus (*Fig.* 372); reduction is gradually effected, and is maintained as a result of the relaxation of the posterior muscles of the flexed leg, and the action of the continuous extension; the leg hammock, which forms a sort of carriage running on sloping rails, allows free play to the extending force, without any interference from friction, and further "transforms part of the action of the weight of the limb into traction on the segment below the seat of fracture."

Heitz-Boyer's apparatus, the principles of which we have already described (see FRACTURES OF THE HUMERUS), here again requires the continuous use of radioscopy for its proper application. The following steps are to be observed:—

1st step.—**Putting on a Close-fitting Legging; fitting a heel cushion, a double popliteal cushion, and a posterior plaster gutter.**—Just as in putting the sleeve on the arm, prior to the use of the corresponding apparatus for fractures of the humerus, the leg covering is rolled up, slipped over the foot, and unrolled from below upwards over the leg, which is held as steadily as possible by an assistant; it is carefully stretched, and every wrinkle obliterated.

A single oval cushion is arranged under the heel and the tendo Achillis, with the inflation tube downwards, and is secured in position by a few turns of a soft bandage. A double cushion is placed behind the knee; one of the chambers being above, and the other below, the popliteal fold; it is fixed like the first. The tube of the upper chamber lies behind the thigh, that of the lower chamber at the inner side of the leg.

A plaster gutter is prepared with six thicknesses of muslin, long enough to go from the roots of the toes to mid-thigh; a hole is made in it at the heel for the tube of the lower cushion, and two concavities are cut at the position of the malleoli. It is then applied (*Fig.* 373); before it is dry, the cushions are distended with tepid water. The rest of the procedure is deferred till the following day, and owing to the presence of this temporary gutter, the remaining manœuvres can be carried out without causing the patient any pain.

2nd step.—**Construction of two Plaster Collars, upper and lower.**—The upper plaster collar is placed below the knee, two inches from the apex of the patella; it is four inches wide. The corresponding portion of the posterior plaster gutter is softened by the application to it for five minutes of a piece of wool moistened with water. The plaster bandage is rolled round the leg at the proper level, care being taken to avoid causing any constriction; after ten or twelve turns have been applied, the *external base-plate* is put in position with the tip of the arm directed towards the foot, and steadied by a couple of turns, then the internal plate is fitted, and both are fixed by eight turns or so more of the bandage.

At the foot, the dorsal bi-malleolar cushion is first put in position: this cushion has three chambers—one median and larger, which must fit over the anterior part of the tarsus and the bases of the metatarsals; two lateral, malleolar, which should be fitted rather above than below the malleoli (*Fig.* 374). This triple cushion is all-important, as through it the pressure is transmitted. Over it, a plaster shoe (the lower collar) is

Fig. 373.—Heitz-Boyer's apparatus. 1st step: Application of the legging, the popliteal and heel cushions and the temporary plaster gutter.

made by a sufficient number of turns of a plaster bandage, care always being exercised to avoid undue constriction; and in the sides of the shoe, at positions midway between the front and the back of the ankle, two base-plates are fixed as before, but this time with the arms directed upwards.

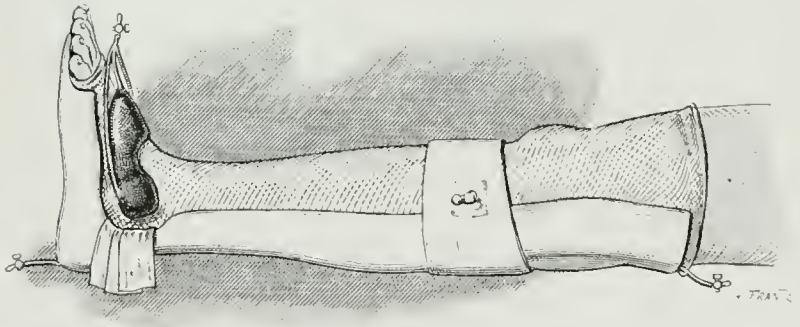


Fig. 374.—Heitz-Boyer's apparatus. 2nd step: Application of the plaster collars (upper one completed); the bi-malleolar cushion in position.

The bi-malleolar cushion is filled with tepid water, and the collars are allowed to dry.

3rd step. — **Putting the Inclined Plane in place, fitting the extension-tubes and the weight.**—To the action of the extension-tubes, the influence of the inclined plane, and extension by weight, are added.

The inclined plane is shown in *Fig.* 375 ; at its lower part, two vertical arms are fixed, each of which supports a very obliquely-placed gutter ; the foot rests on the inner margins of these gutters, the weight being transmitted through two small rollers screwed to the arms of the lower pair of base-plates.

The extension-tubes are then fitted, a moderate degree of tension being imparted to the springs. A cord is attached to the arms of the two lower base-plates, and by means of it weight extension is provided as in Hennequin's method.

All that then remains to be done is to divide the temporary posterior plaster gutter with a Gigli saw, a little above the lower collar, a little below the upper collar, and to remove the intermediate portion (*Fig.* 376).

The apparatus is now complete ; according to the information furnished by radioscopy, various measures will be adopted for the purpose of correcting any displacement which may still remain. Attention is first

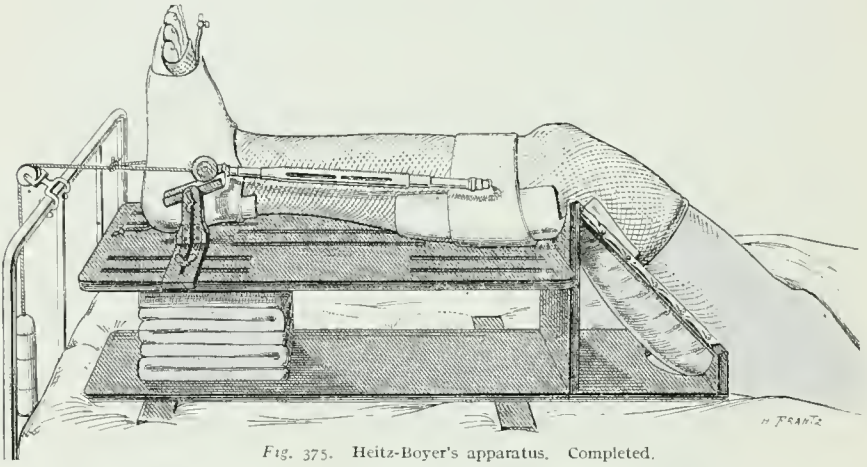


Fig. 375. Heitz-Boyer's apparatus. Completed.

directed to reduction in the antero-posterior line. To raise a backwardly-displaced fragment, a wedge composed of folded compresses is slipped under the limb at the proper level. To push back a fragment which is projecting in front, a cushion is arranged over the projection, and over the cushion a band is placed, and its two ends passed through the median slots in the inclined plane ; by their means vertical or oblique traction can be exercised as required when the cushion is filled.

The same method is followed in correcting lateral displacements. A cushion is applied over the displaced fragment, and a band over the cushion, taking its support from the extension tube on the opposite side of the limb, holds the cushion in position, and helps reduction ; to avoid circular constriction of the limb, one of the ends of the band must, however, be passed through the median slots.

Each day the position of the bones is verified, and the apparatus modified according to the radiographic findings, until complete reduction

in all directions has been obtained. The time necessary for this result depends on the type of fracture, as a rule ; according to M. Heitz-Boyer, it varies from three to six days. The apparatus is then left in place, the extension being, however, a little relaxed ; a week later, an ordinary

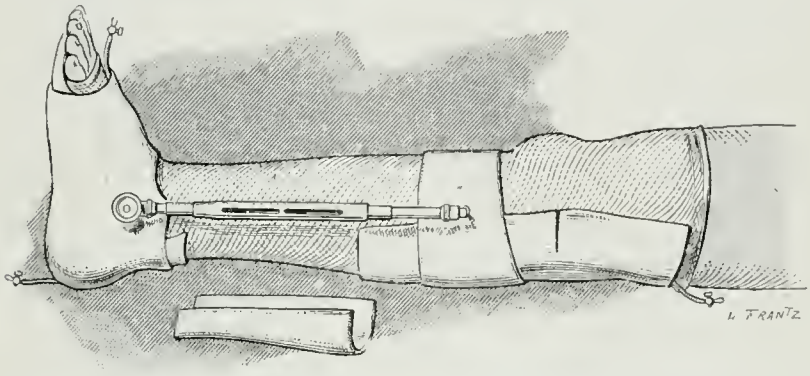


Fig. 376.—Heitz-Boyer's apparatus. Removal of the leg portion of the temporary plaster gutter. Extension tubes in position, between the upper plaster collar and the plaster shoe.

plaster case may be substituted for it, but it is usually much better to allow it to remain until union is complete.

If a bad, very oblique fracture has to be treated, and neither Hennequin's nor Heitz-Boyer's apparatus is obtainable, it will, at least, always be possible to improvise an inclined plane, to fit the plaster " traction shoe " and the leg gutter, and so to provide continuous extension with the leg

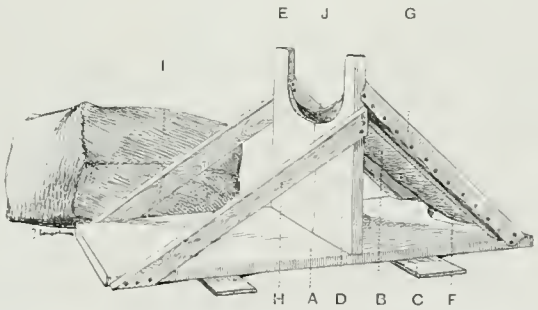


Fig. 377.—Hennequin's apparatus improvised. (A) Base board. (B) Supporting cross-pieces. (C) Notch cut to receive the hip. (D) Vertical board. (E) Arms of the vertical board forming the borders of the notch for the knee. (F) Thigh hammock. (G) Inclined supports. (H) Lateral bars. (I) Leg cushion. (J) Anterior border (sub-popliteal) of the thigh hammock.

flexed (or to speak more correctly, with the leg horizontal and the thigh flexed, which produces the same result, i.e., relaxation of the posterior muscles).

For the purpose of meeting these conditions, M. Hennequin has devised the apparatus represented in *Figs.* 377 and 378. It has been constructed and used in our hospital service, and can be improvised anywhere.

Take a piece of board, 9 inches broad and 30 inches long, hollow it out at the upper border, which must extend up to the ischium ; underneath it nail two cross-pieces, to serve as supports to prevent lateral inclination.

On this base-board, at the junction of its lower two-thirds and upper third, a smaller piece of board, 12 inches long and of the same breadth as the larger, and hollowed out to a depth of 4 inches at its upper border, is fixed vertically.

Two pairs of obliquely-placed supporting bars are fixed by nails or screws to the two boards in the manner shown in *Fig.* 377 ; a piece of some strong material (the covering of a mattress, etc.) is nailed to the upper pair of supports, and stretching between them will form the thigh hammock.

The leg hammock is replaced by a firmly-packed chaff pillow, arranged as in *Fig.* 378 ; the two oblique bars serve to keep it from being displaced

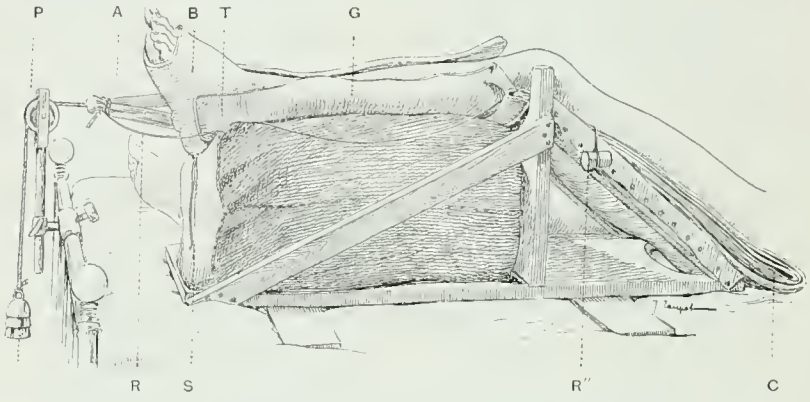


Fig. 378.—Hennequin's apparatus improvised. In use. (A) Extension stirrup. (B) Plaster shoe. (C) Cushion for thigh. (G) Leg gutter. (P) Pulley and cord supporting the weight. (R) String attached to the cord, extending up along the limb and tied to a cork R'', which the patient keeps at his side, and which enables him by pulling on it to relax the extension, in certain movements of the trunk. (S) Cushion interposed between the skin of the heel and the plaster shoe, and furnished with a string whereby it can be withdrawn. (T) The malleolar prolongations of the leg gutter.

laterally. Or, again, instead of using the pillow, the leg hammock may be improvised as follows : the two lateral bars (H, *Fig.* 377) are not fixed at both extremities, they are left altogether free at the lower ends, and are jointed above to the edges of the vertical board D (in other words, they are connected to the sides of this board by two screws which are not driven quite home). Between the two bars a piece of sheeting is stretched and nailed to them, and forms the hammock. A Y-shaped piece of wood serves to support them ; its lateral branches are jointed (by screws as before) with the bars ; its median branch is free, and engages in one of a series of notches, cut rack-fashion, in the base-board (A, *Fig.* 377) for its reception. By means of this movable Y the inclination of the leg hammock can be varied, and the apparatus approximated a little more closely to the original form.

With this simple apparatus, continuous extension can be obtained

with the thigh flexed; the rolling carriage, above described, which transforms the weight of the limb into an extending force, is, of course, wanting, but still the principal features of the apparatus are preserved.

The plaster shoe and leg gutter are constructed in the manner already described, and continuous extension is provided as before; the extending apparatus may also be improvised if necessary.

Lastly, in some circumstances and in certain surroundings these improvised forms of apparatus, which take up a good deal of space and require constant watching, are less useful than immediately encasing the limb in a simple plaster gutter.

In these conditions, adequate results will only be obtained under the express reservation, *that reduction is affected forthwith, and as exactly as possible, by the methodical application of whatever means are available.*

Do not hesitate to have recourse to general anæsthesia;[1] it is certainly worth the trouble; for, as I have already said, it is an actual operation, and indeed an important operation, which has to be performed.

The assistant who is charged with the counter-extension flexes the thigh, and raises the knee; the surgeon grasps the foot, and pulls in the axis of the leg, or a little obliquely inwards or outwards according to the nature of the displacement.

If the lower fragment descends and comes into line, if the leg recovers its natural length and shape, the knee is slowly lowered and the limb placed in the extended position, the traction on the foot being maintained all the time. This will be a severe test; too often the reduction which has been obtained with the leg flexed, disappears as soon as the limb is extended.

If no displacement recurs, then at once apply a plaster gutter, enveloping the circumference of the limb sufficiently and extending up to the lower third of the thigh. Once more make sure that the foot is in good position at right angles to the leg, and see that the counter-extension, the traction in the axis of the leg, and the direct pressure on the upper tibial fragment are kept up till the apparatus is perfectly dry.

Here let us mention the plan recommended by Hennequin and Loevy for applying the plaster apparatus to the leg under traction. "After having placed a pillow under the lower extremity of the leg, and protected the dorsum of the foot, the back of the heel, and the tendo Achillis with a few thicknesses of lint, the operator places below the heel the loop of a strong bandage, the ends of which are brought forward on either side of the ankle over the malleoli, and crossed over the tarsus, and then carried directly towards the waist of an assistant standing at the foot of the bed." They are then knotted together behind the back of the assistant, who, having his hands resting on the cross-bar of the bed, need only lean back

[1] Or local anæsthesia at the seat of fracture: the skin having been submitted to the usual aseptic preparation, 50 to 100 minims of a ½ per cent solution of cocaine are injected with a long needle, right down to the fragments, into the interval between them, and around them: pain and muscular rigidity disappear in a few minutes, and reduction is easily effected. (See G. Lerda, *Zentralblatt fur Chir.*, 7 déc., 1907; also Quénu, *Soc de Chir*, 22 juillet, 1908.)

and extend his forearms to exert very powerful traction. Posterior and stirrup splints of plaster are then prepared; the stirrup splint is cut at the middle, and the lower ends of the two resulting lateral splints are slit up for a length of 4 inches. The posterior splint is applied first, then the two lateral splints, the traction bands passing through the slits in the latter, and the four ends are then folded under the sole. The assistant keeps up the traction till the plaster has set.[1]

A point of capital importance is the inspection and re-application of the apparatus during the course of the treatment. Too often, after the fixation apparatus has been applied, it is not touched until the time when union may be expected to have come about; it is then removed, and not uncommonly some undue projection of one of the fragments and unexpected mobility is found. As a matter of fact, after ten or fifteen days from the time of application of the apparatus, the limb has shrunk so much that it is no longer properly fixed, and as the fragments are still very imperfectly united, they are liable to again become displaced. It is therefore necessary to keep a close watch over limbs which have been put up in plaster, and frequently to verify, particularly in the first weeks, the maintenance of reduction; and if there is any reason for it, there should be no hesitation in removing and reapplying the apparatus.

When the displacement cannot be corrected, and when the projection of the upper fragment reappears, as soon as the limb is extended, the leg may sometimes with advantage be immobilized **at an obtuse or at a right angle.**

M. Quénu described a case of this kind to the Société de Chirurgie, in May, 1899. It was a fracture of the leg at the lower fourth, with considerable displacement of the fragments, which could not be kept in proper position. On flexing the leg to a right angle with the thigh, reduction became easy.

The plaster apparatus was therefore applied on the leg flexed at a right angle, and resting on its outer side on the bed. A simple band sufficed to keep the upper fragment reduced; the band was removed on the sixteenth day. Union took place with two-thirds of an inch of shortening.

At the end of two or three weeks, when union is fairly well advanced and the callus is sufficiently strong, an ordinary gutter splint may be applied, the knee being brought very carefully into the extended position. But again we must say, that in cases where the displacement constantly tends to recur, nothing is so good as continuous extension on an inclined plane.

What has just been said applies also to **spiral fractures, comminuted fractures,** and **double fractures of the tibia with an intermediate fragment** (*Fig.* 379).

Some of these complex displacements may be quite irreducible, even under general anæsthesia or with continuous extension. One of the

[1] Hennequin et Loevy, *Loc. cit.*, p. 108.

fragments lying crosswise, or even sometimes turned up, may offer an insurmountable mechanical obstacle to coaptation of the two principal ends; or, again, one of the tibial extremities, very oblique and sharp-pointed, may be deeply and inextricably embedded in the muscles; or the upper tibial fragment may have penetrated the deep layers of the skin without actually perforating it, and cannot be disengaged.

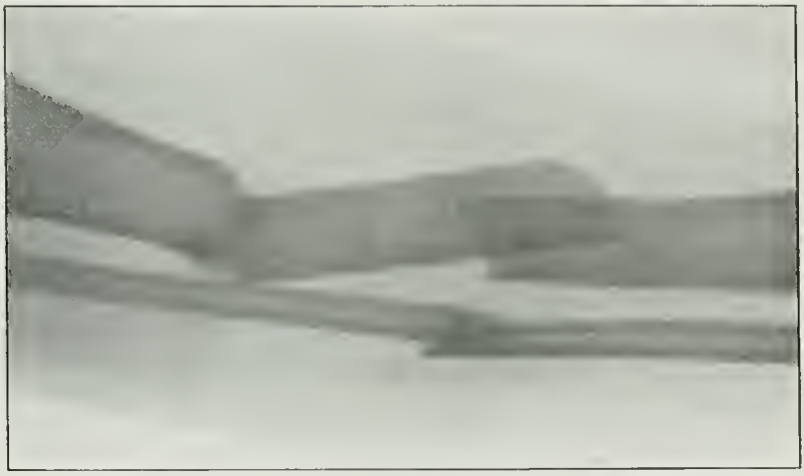


Fig. 379.—Fracture of the leg. Double fracture of the tibia, with intermediate fragment.

In such conditions, open reduction becomes necessary (see later, COMPOUND FRACTURES). Apart, however, from such special indications, it does not seem that in ordinary practice there is a very large field for operative measures in the treatment of simple fractures.

FRACTURES OF THE UPPER PART OF THE LEG.

Great effusion of blood, frequent hæmarthrosis, very slow bony union, joint stiffness, often to the extent of complete rigidity: these are common consequences, and hence, consequences which must be foreseen and predicted, of a fracture of the upper end of the tibia, whether associated or not with a fracture of the fibula. Add to this the possibility of vascular complications and secondary gangrene, and one has a good idea of the gravity of these injuries.

Further on we shall see what ought to be done in the presence of *vascular lesions* and *compound fractures*.

Let us consider first of all a type of medium gravity, if I may use the expression.

It is always difficult to make an exact diagnosis at once. The knee and the upper part of the leg are enormously swollen ; and the joint itself, as a rule, distended with blood. The profuseness of the hæmorrhagic effusion is in itself a strong indication of the existence of a fracture.

Examine carefully the patella, the femoral condyles, and the tuberosities of the tibia ; often it is from the *local pain* alone that the diagnosis can be made and the character of the osseous lesions approximately recognized.

Less commonly some definite deformity is discovered, a sort of *bending forwards* of the upper tibial extremity, the articular portion of which appears to be displaced backwards ; or undue projection of one of the tuberosities ; or, again, *multiple fragments*, which by their irregular displacement cause great deformity of the head of the tibia, and under the pressure of the fingers give coarse crepitus. All these conditions are ordinarily masked by the swelling and the effused blood.

What is to be done ? To try to effect reduction with the guidance of the very uncertain local signs, and to immobilize the limb forthwith in a plaster apparatus, is a procedure of very doubtful utility, and one which will often be dangerous. It must not be forgotten that gangrene has on several occasions occurred under the compression of immediately applied apparatus.

Begin, therefore, by carefully cleansing the whole of the injured region, surround it with sterile gauze moistened with boiled water, and envelop it in a thick, lightly bandaged layer of wool, then raise the limb, and place it on an inclined plane, which can be easily improvised anywhere, and secure it with a few straps.

Next day, or the day after, if the hæmarthrosis is very large, the joint should be aspirated, and the use of the moist dressings continued for several days, and the limb kept at rest and well raised.

Under this *preliminary treatment*, the pain diminishes, the swelling subsides, and, at a subsequent examination, it will be possible to determine more exactly the nature of the lesions and the osseous deformity.

If the deformity is not very marked, the best plan will be to begin massage at once, without immobilizing the limb ; this will be the best means of hastening consolidation and, at the same time, saving as much as possible of the function of the joint.

If, however, there is a notable displacement backwards of the bony plate which bears the articular surfaces, an abnormal projection of one of the tuberosities, or an actual angulation of the upper extremity of the tibia, **the deformity must be reduced**, and to do it properly chloroform must often be given.

Traction applied to the leg, combined with direct pressure on the displaced fragments, will usually effect reduction. Immobilization is necessary by means of a posterior plaster gutter extending from the middle of the leg to the middle of the thigh, or Hennequin's apparatus may be used.

The limb must be kept in the splints for some weeks, and then massage and systematic movements will be begun.

In cases of this kind, in suitable surroundings, exposure of the seat of fracture, open reduction of the fragments, followed by their fixation by suture or clamps, would perhaps give the best results; in general practice, however, it is scarcely applicable.

With regard to **the isolated fractures of the upper end of the fibula,** it is necessary to mention: (1) *The fracture of the upper third,* with or without separation at the tibio-fibular articulation; (2) The fractures *by the tearing of the head of the fibula.*

1. **Fracture of the Upper Third.**—After all injuries of the ankle and leg, it is advisable to examine the fibula from below upwards in its entire length. Fracture at the upper third is not uncommon; it renders itself evident by a fixed local pain, irregularity of the axis of the bone, sometimes by definite crepitus. When these conditions are found, it is always necessary to return to the ankle, and seek for a separation (diastasis) at the tibio-fibular articulation.[1]

It is not constantly present, although these fractures of the upper part of the fibula may ordinarily be ranked under the common title of **Maisonneuve's fractures by diastasis**; if it is absent, the accident is less serious, immediate massage is indicated, and the patient may be allowed to walk after a few days.

When a true diastasis exists, a separation of variable extent between the tibia and fibula at the inferior tibio-fibular articulation, and the case is really one of typical fracture by diastasis, the prognosis is very different, and particularly if the complication has at first been overlooked or inadequately treated. It may ultimately give rise to very serious disability in standing and in the movements of the foot, the cure of which will be exceedingly difficult.

Broadening of the ankle should always make one think of a diastasis. If there is not too much swelling, it may be possible to detect by palpation that the external malleolus is displaced laterally as a whole, it is not simply tilted outwards, but displaced *en masse*, and can be moved from before backwards, and from within outwards; radiography is necessary for the confirmation of the diagnosis.

In the presence of this inferior tibio-fibular diastasis the foot must be immobilized in plaster forthwith after exact reduction, and the apparatus must be closely watched and reapplied later, when the subsidence of the swelling allows some play to the malleolus.

2. **Fracture by Tearing of the Head of the Fibula.**—In these cases the external popliteal nerve is often injured; the fracture is then accompanied by extremely acute pains radiating over the whole of the corresponding half of the leg; such pains should always attract attention.

[1] Quénu, "Du diastasis de l'articulation tibio-péronière inférieure." *Rev. de Chir.*, 1907, t. i., p. 897, and t. ii., p. 62.

On several occasions, indeed, a limb has been immobilized at once, and it was only at a later date, on the removal of the apparatus, that the paralysis of the antero-external muscles of the leg was recognized.

Therefore, investigate these abnormal pains closely, enquire as to the zone into which they radiate, see if there is any anæsthesia in the areas of cutaneous distribution of the anterior tibial and musculo-cutaneous nerves, and if there are already any indications of muscular weakness.

Then try to bring the head of the fibula, which has been dragged upwards by the biceps, down into its place; if the pains cease when coaptation has been obtained, one may be content with applying a well-padded bandage, or a silicate apparatus, with a tampon placed underneath to prevent a recurrence of the upward displacement of the head.

Fig. 380.—Fracture of the upper end of the fibula. Exposure of the seat of fracture and the external popliteal nerve.

More often coaptation will be impossible, or the nervous troubles will persist; this will be an indication for **immediate operation.**

The site of fracture, the bicipital fragment of the bone, and the diaphyseal surface, will be exposed by an external lateral incision in the line of the upper part of the fibula. With great care the lacerated muscle fibres will be retracted, and **the external popliteal nerve looked for at once**; it is easily found by working from above downwards, and from behind forwards (*Fig.* 380), taking as a guide the tendon of the biceps, immediately behind which it lies. The nerve is disengaged and drawn aside.

The next step is to bring the two bony fragments into contact, and to fix them by one or two sutures, placed in such a way as not to injure or compress the nerve. If any difficulty is experienced in bringing down the head of the fibula, the best plan is simply to excise it by dissecting it out from the surrounding tendinous fibres. The diaphyseal end will be rounded off, and the external popliteal nerve replaced where it will be free from harmful compression.

FRACTURES OF THE LOWER PART OF THE LEG.

These are the **supra-malleolar** and **bi-malleolar fractures.** We shall not refer to *the isolated fractures of the malleoli* and *the fractures by tearing the lower end of the fibula*, all of which are best treated by massage alone.

Supra-malleolar Fractures. *Fig.* 381 represents a type of supra-malleolar fracture with backward displacement of the heel; the line of fracture is oblique downwards and forwards; the upper fragment lies in front of the ankle, the heel falls back, the forepart of the foot appears shortened, the back part elongated. At first sight, the condition looks like a dislocation backwards of the ankle.

Fig. 381.—Supra-malleolar fracture, with backward displacement of the heel.

It must be reduced. Naturally reduction is not always easy, but it must always be as correct as possible. Any deformity which persists, however small, will express itself by a vicious inclination of the foot and by an interference with its usefulness which is always serious.

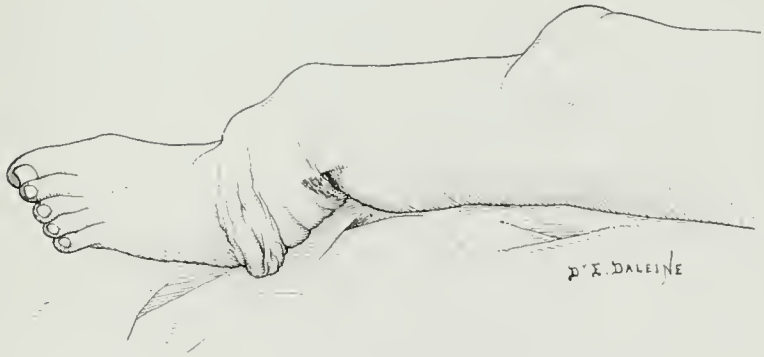


Fig. 382.—Comminuted supra-malleolar fracture, with displacement of the foot backwards and outwards.

Have the leg flexed and the knee held, then grasping the foot as before, **pull in the axis of the limb, at the same time raising the heel.** If needful, if reduction is not quite satisfactory, the foot is given to an assistant, who will maintain the traction while the surgeon applies direct pressure with the thumbs on the projecting upper fragment, and pushes it back into place.

In another and much rarer type the line of fracture is oblique in the opposite direction, **downwards and backwards**; the upper fragment slips backwards and displaces the tendo Achillis, the whole foot is carried forwards as if dislocated.

Reduction will be effected by traction in the axis of the flexed leg, while at the same time the foot is pushed backwards.

The line of fracture may be oblique outwards (*Fig.* 383) or inwards, the displacement lateral, and the rotation of the foot very considerable, as shown in *Fig.* 382.

Fig. 383. Supra-malleolar fracture, obliquely outwards; great deviation of the foot. (Bouvier's specimen, 1871, Musée Dupuytren, 237 A.)

Fig. 384.—Dupuytren's bi-malleolar fracture.

Immobilization in a plaster gutter must follow reduction, the foot being carefully maintained in correct position until the apparatus is thoroughly dry.

Bi-malleolar Fractures. I now come to the bi-malleolar fractures, and especially to **Dupuytren's fracture** (*Fig.* 384), the type of bi-malleolar fractures with great displacement.

The foot *is displaced outwards and somewhat backwards*; a deep depression on the outer side marks the point of fracture and bending of the

fibula; on the inner side, the upper fragment of the internal malleolus forms a projecting ridge, which stretches and bruises the overlying skin; the astragalus moves from side to side in the enlarged socket of the ankle joint.

Here, again, immediate and exact reduction is essential. One must never be content with incomplete reduction. A slight degree of deformity must not be left to the future, to be corrected during the after-treatment, when it can be set right at once, with chloroform, if necessary. Too many cases of vicious malleolar union are seen; too many secondary operations have to be performed for the correction of these deformities, and the disabilities which result from them, to permit of any doubts as to the soundness of these precepts.

Flexion of the leg is always a very useful preliminary step; traction is then exercised in the axis of the limb, and at the same time the foot is drawn firmly inwards.

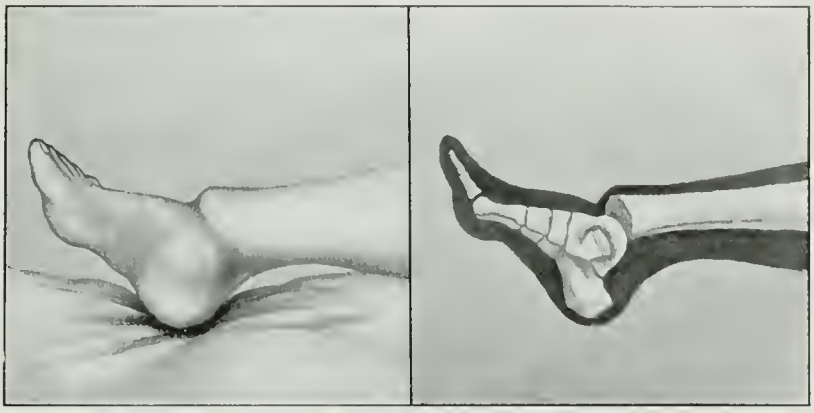


Fig. 385.—Bi-malleolar fracture, with displacement of the foot backwards.

A better result will sometimes be obtained by laying the inner surface of the ankle against one's knee, and while it is held with the left hand against this solid point of support, the right hand, grasping the sole with *the thumb on the external malleolus*, slowly and steadily corrects the displacement and restores the foot to its proper position.

It will very seldom happen that with care—and under chloroform—reduction cannot be effected.

Still complete irreducibility may be met with; in such cases, remember the possibility of **a wedge-shaped fragment,** a splinter from the external surface of the tibia, being interposed between the articular surfaces, and so forming an insurmountable obstacle to reduction, because of the impossibility of getting hold of it.

In the event of final failure, and if a notable degree of deformity remains, then reduction by open methods is indicated (see later).

The best apparatus—need it be said ?—is **a plaster gutter**, carefully watched while drying, as we have so often emphasized, and renewed later if, once the initial swelling has subsided, it ceases sufficiently to control the limb. Not only must care be exercised to keep the foot at right angles to the leg, but also **to correct the displacement of the heel**, which almost always falls backwards in these fractures (*Figs.* 385 and 386).

Dupuytren's splint cannot be compared with the plaster gutter ; but it is still very useful as a temporary emergency apparatus.

A long splint can be fashioned anywhere, a cushion can always be obtained, and bandages always made out of old linen. The splint is applied

Fig. 386.—Bi-malleolar fracture, with backward displacement of the foot.

to the inner surface of the limb, so that it extends beyond the sole of the foot ; the cushion is arranged between the splint and the limb, and is folded back at the level of the internal malleolar fragment, so as to form a thick pad there. Splint and cushion are fixed to the limb at the knee and above the ankle by two roller bandages. Reduction is then effected, and the foot maintained in adduction by a third bandage, taking its support from the splint, and applied as shown in *Fig.* 387.

In applying this reducing bandage, care must be taken to raise the heel ; but, however it is done, the heel always in the end falls back again. Dupuytren's splint can therefore only be considered as a temporary appliance, but may still be useful in certain places, in moving the patient, etc.

We cannot devote much space to the consideration of **the ambulatory treatment of fractures,** which can scarcely be considered as a method of general application. However, it may be very useful in certain circumstances, for fractures of the leg in particular, and it is desirable that every practitioner should be equal to carrying it out.

Of course, in urgent surgery there can be no question of special orthopædic apparatus, but the following plan, if properly executed, will give very good results.

The limb is enveloped in a sheet of lint, which extends from the toes to above the knee ; a plaster bandage is applied from below upwards, the turns overlapping, and undue constriction being avoided. In this way a

Fig. 387.—Dupuytren's splint. Applying the bandage round the foot.

plaster case is made, the upper border of which lies two inches below the knee ; the leg is maintained in good position during the application of the bandages and until the apparatus is completed (*Fig.* 388).

Over this inner case, the stirrup is next arranged ; the stirrup is a double zinc rod, long enough to extend up the sides of the leg to just below the tuberosities ; the upper extremities of the lateral branches are expanded into flat plates. The two lateral branches are adjusted in the axes of the malleoli, and so that the cross-piece lies about an inch below the sole.

The stirrup is next fixed by rolling a plaster bandage around the end-plates (*Fig.* 389). A good many turns are required, especially over the upper margins of the plates, so as to cover them in completely, and prevent them from afterwards slipping upwards.

A second plaster bandage is then applied lower down, at the supramalleolar region (*Fig.* 390), care being taken to press the turns of this

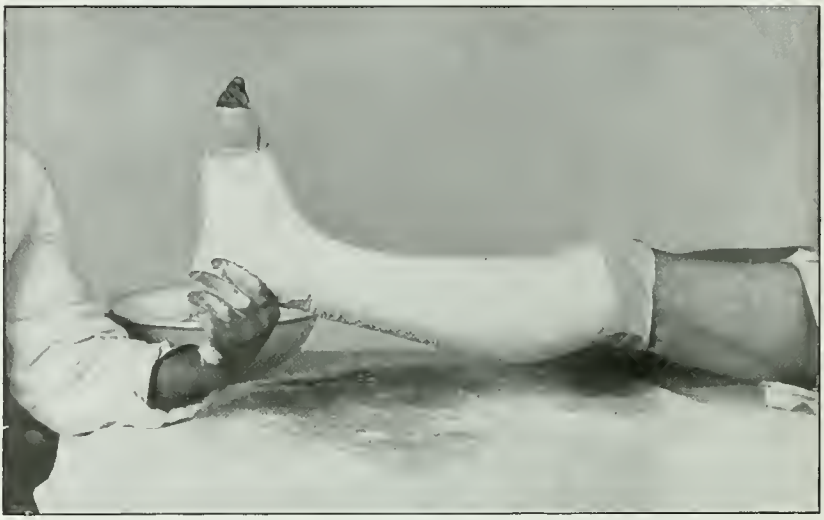


Fig. 388.—Ambulatory apparatus for the leg. The inner plaster case applied.

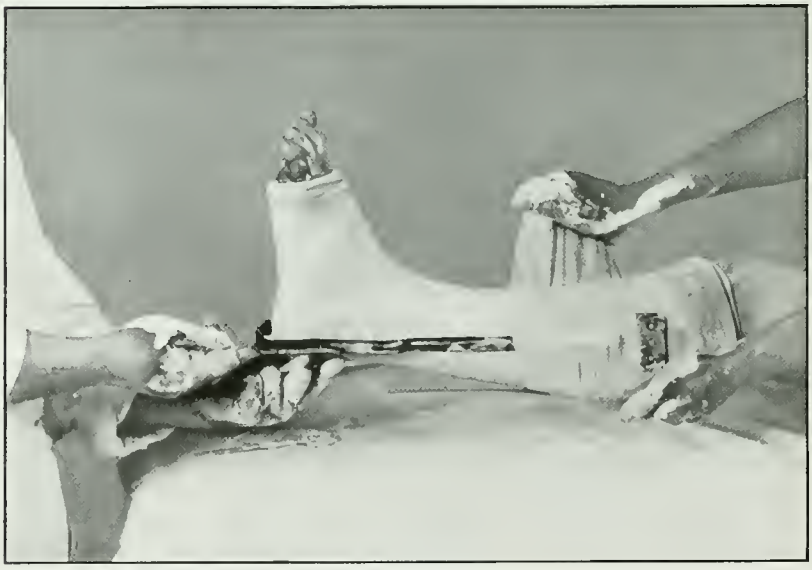


Fig. 389.—Ambulatory apparatus for the leg. Fitting the stirrup; fixation of the two end plates.

bandage with the thumbs down against the margins of the stirrup, in order to fix it as completely as possible.

Place a sheet of mackintosh under the apparatus, and leave it to dry; no attempt must be made to walk on it till the following day, after its condition has been ascertained.

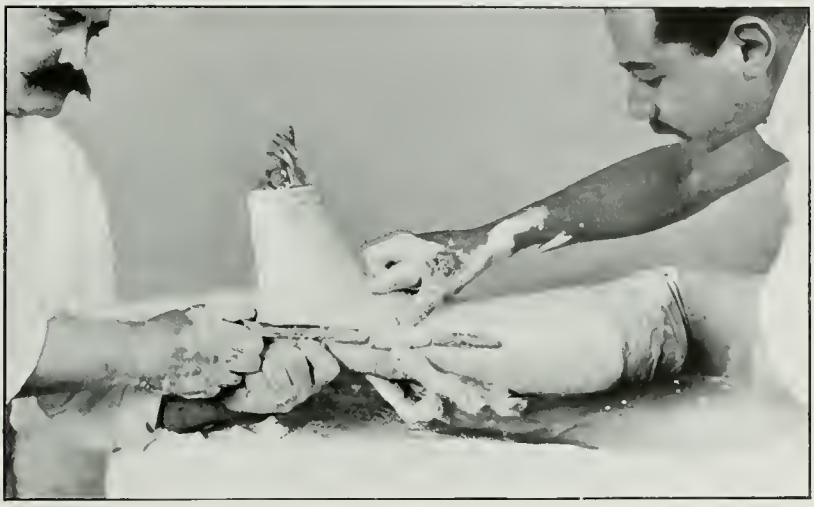


Fig. 390.—Ambulatory apparatus for the leg. Fixation of the stirrup above the malleoli.

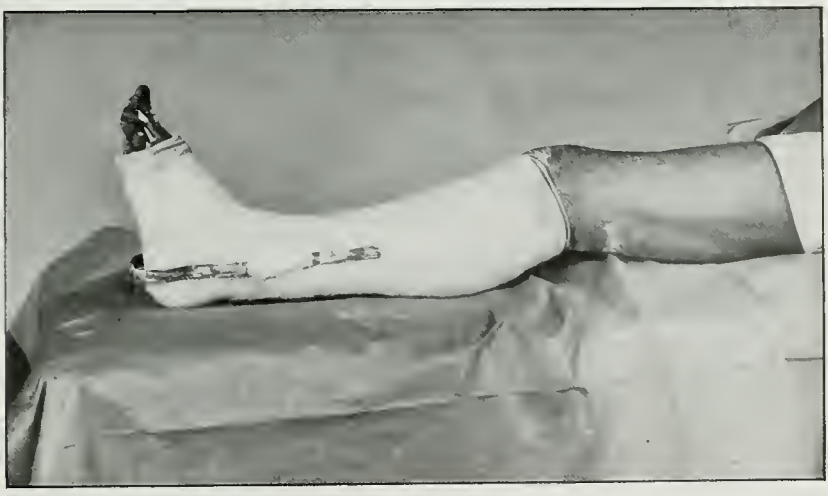


Fig. 391.—Ambulatory apparatus for the leg. The apparatus completed, and in process of drying.

The patient walks on the transverse, subpedal bar of the stirrup, from which the weight is transmitted directly to the tibial tuberosities, the seat of fracture and the foot remaining, as it were, suspended between the two lateral branches.

XI.—Fractures of the Bones of the Foot.

Fractures of the Os Calcis.—Two types require to be distinguished: (1) *Fracture by crushing* (Malgaigne's fracture); (2) *Fracture by tearing* (Boyer's fracture), much less common.

1. **A crush of the os calcis** (*Fig.* 391) generally results from a fall on the heel; it may be unilateral or double. The heel is flattened and broadened, the plantar arch obliterated, the malleoli lower than normal, and the foot slightly everted. When the lesion is unilateral, the deformity is at once seen when the two feet are compared, especially when they are examined from behind. Pressure from below, and also transversely, on the os calcis elicits an acute pain—this is a very valuable sign in cases where the swelling is great. M. Destot has described different varieties of this fracture, according as it affects the anterior, the middle, or posterior segments of the bone.[1]

Fig. 392.—Fracture by crushing of the os calcis.

The fracture of the os calcis by crushing is a particularly painful condition, and the pains are very persistent, and give rise to great difficulty in walking. They are due to flattening of the internal plantar groove and compression of the structures which traverse it (plantar nerves).

An attempt should always be made to effect reduction; the knee being flexed, the fore-part of the foot is grasped with one hand and the heel with the other, and strong lateral traction inwards and outwards, tending to invert and evert the foot, is exercised. If nothing yields, an effort is made to draw the heel forwards, and the foot is adducted and abducted. Complete reduction cannot always be obtained.

The foot is immobilized for a short time, and then massage and local gymnastics are begun, and pursued for a long time.

2. **The fracture by tearing** is due to the sudden and violent action of the muscles attached to the tendo Achillis; it involves the postero-superior part of the os calcis, and detaches a wedge-shaped piece of bone, with the apex directed forwards. The fragment is displaced forwards and upwards (*Fig.* 394), and often perforates the skin. On palpation the bony

[1] "Fractures du tarse postérieur." *Rev. de Chir.*, 10 août, 1902, No. 8, p. 218.

wedge is felt, and its projecting posterior border can be recognized, as can also another sharp ridge on the os calcis.

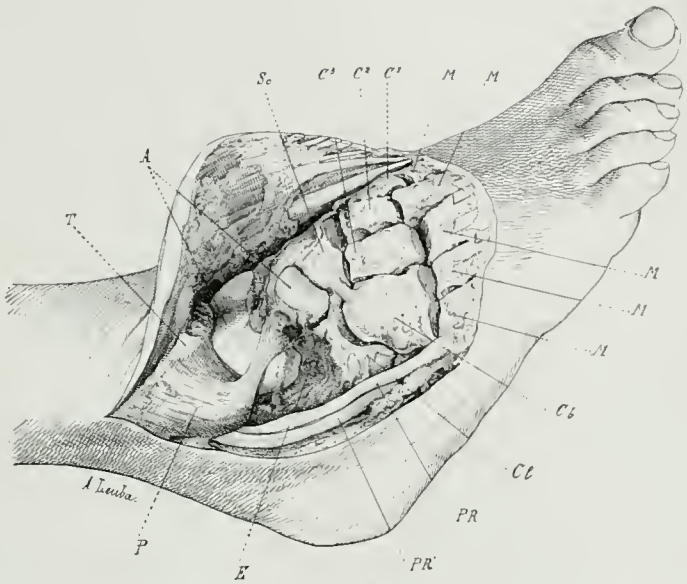


Fig. 393.—Bones of the tarsus and metatarsus (dorsal surface). (T) The anterior border of the lower end of the tibia. (A) The astragalus. (Sc) Scaphoid. (C^1, C^2, C^3) 1st, 2nd and 3rd cuneiform bones. (MMMMM) The five metatarsals. (Cb) The Cuboid. (Cl) The os calcis. (PR) Peroneus brevis. (PR') Peroneus longus. (E) Astragalo-calcaneal groove. (P) External malleolus.

The best treatment—and the presence of a contused wound is often another indication for it—consists in opening up the area by a posterior vertical incision, and the leg being flexed, and the foot strongly extended, bringing the detached fragment down into contact with the fractured surface of the os calcis, and fixing it in position by two lateral sutures,[1] or by means of a bone staple (see later, Reunion of Fractured Bones).

Fig. 394.—Fracture by tearing of the os calcis (diagrammatic).

Lastly, **isolated fractures of the anterior extremity of the os calcis** (*Fig.* 395), or of **the internal tubercle** (sustentaculum tali), which is displaced into the hollow at the inner side

[1] See the paper by Tuffier and Desfosses, "Fractures du calcanéum par arrachement. *Presse médicale*, 13 avril, 1898, p. 177; Potherat, *Soc. de Chir.*, 7 nov., 1900, p. 1010; and François Hue, *Ibid.*, 14 nov., 1900, p. 1019.

of the os calcis, and compresses the plantar nerves,[5] may be observed. The foot is in a position of valgus; pain can be elicited by pressure on the inner side of the heel below the internal malleolus, and in the same position the displaced fragment can be more or less definitely felt.

Fig. 395.—Fracture of the anterior extremity of the os calcis.

Fractures of the Astragalus.—These are fairly often complicated by dislocations (see above). When occurring as isolated injuries, they may belong to different types, which have been carefully studied experimentally;[1] but, though they may be discovered by radiography, can hardly be recognized by an ordinary examination. Thus we may see **transverse fractures of the neck**, detaching the head of the bone; or **of the body — sagittal fractures**, the line of fracture of which is always oblique from behind forwards; or fractures **of the posterior tubercles.**

It is necessary to remember, that in a fracture of the astragalus, the foot is displaced inwards, the external malleolus very prominent, the sole of the foot usually inverted, and the inner border shortened. In the cases where deformity persists, the foot is in a position of equino-varus.

Removal of the astragalus is certainly the best line of treatment, and if there is a wound should be adopted without hesitation. Of course, the surrounding conditions must be taken into consideration before deciding on operation.

Fig. 396.—Fracture of the 1st metatarsal bone.

[1] See Ombrédanne, "Etude des fractures de l'astragale," *Rev. de Chir.*, 10 août, 1902, No. 8, p. 177; et No. 9, p. 414.

Fractures of the other Bones of the Tarsus (*Fig.* 393).—The diagnosis will depend on the local pain, the deformity, and particularly on the radiographic findings. They ought to be treated by rest and massage. I need not stop to consider the comminuted and multiple fractures of the tarsus as a whole, or the crushing injuries, which besides are often compound, and will be more appropriately treated under the heading of compound fractures.

Fractures of the Metatarsal Bones.—These are comparatively common, and one interesting variety may be mentioned: that which occurs, often in both feet, and usually affecting the 3rd metatarsal, in soldiers during forced marches. It manifests itself by obstinate, painful swelling of the foot.

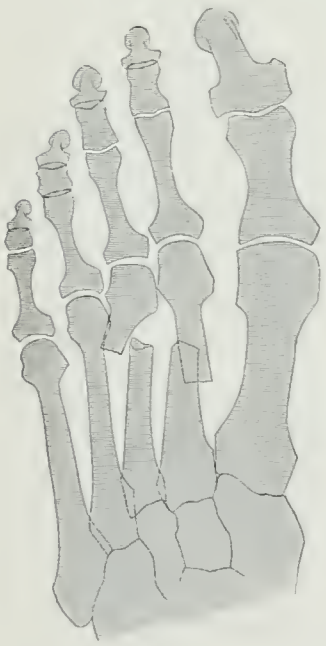


Fig. 397.—Fractures of the 2nd and 3rd metatarsals.

Fig. 398.—Multiple fractures of the toes.

A metatarsal fracture is recognized by local pain provoked by direct pressure, or by compression of the bone in its long axis, one hand fixing the tarsus while the other presses the heads of the metatarsals backwards. The early ecchymosis, in bands over the intermetatarsal spaces, mentioned by Thiery, is also to be noted. Lastly, deviations (*Fig.* 396) or overlapping (*Fig.* 397) are sometimes found, and must be reduced. As a rule, these fractures are treated by rest and massage.

Fractures of the Toes.—The same treatment is applicable here. In cases of multiple fractures the result of crushes (*Fig.* 398), it will be well at first to fix each of the toes, after reduction, between two small lateral splints.

COMPOUND FRACTURES.

Every open fracture, however small the solution of cutaneous continuity may be, is a source of grave danger, local and vital, and the future of these fractures depends essentially on the immediate treatment.

The indications to be met naturally vary according to the character of the osseous lesions, the lacerations of the soft parts, or the associated vascular lesions. Clinically the following groups may be recognized.

1. Compound Fracture with little or no Comminution, no Vascular lesions, no extensive Muscle laceration, and with a small Cutaneous wound.

If the wound is small, merely a perforation of the skin, bleeding, not dirty, and quite recent, it will be well to refrain from opening up the focus of fracture and from any attempts, which are almost always unnecessary, at cleansing the deep parts of the area. Protect the small wound with an aseptic compress and shave the limb widely around, wash it with boiled water and soap and with spirit ; then remove the protecting compress from the wound, cleanse its margins with spirit and the bottom with a dry swab ; when the cleansing has been adequately effected, cover the wound with a piece of sterilized gauze and a little wool, and secure the dressing with a bandage. Then immobilize the limb at once in a plaster apparatus.

It is a different matter when the cutaneous wound is an inch or more in extent and the bones are exposed. In such circumstances, superficial cleansing of the wound and the surrounding area, followed by the application of an occlusive dressing, is never sufficient. I know quite well that such measures may be followed by an uncomplicated recovery ; that only means that by good luck the wound had not been infected. In spite of the most favourable appearances, nothing is known, nothing can be known, of the condition of the wound ; and if the dangers incurred are definitely recognized, if the terrible possibilities associated with these injuries, which appear to be so benign, are known, one will never rest content with passive measures and delay.

The deep, subcutaneous focus must be disinfected. Begin then by soaping and brushing the whole area, washing it with spirit and ether, taking care to keep the wound covered with an aseptic compress, to protect it from avoidable contamination ; then cleanse the wound itself with spirit and boiled salt solution. Next enlarge the cutaneous perforation (*Fig.* 399) sufficiently to give free access to the fragments, and irrigate the whole exposed subcutaneous area freely with very warm boiled salt solution. Wash away the clots, the little splinters of bone, and the débris of all kinds ;

cleanse the spaces between and around the fragments; but during this irrigation and cleansing, be careful to disturb the fractured extremities as little as possible. Open up the way for the solution without stripping the

Fig. 399.—Compound fracture of the tibia. The cutaneous perforation has been enlarged longitudinally.

periosteum, without tearing the muscles, and without causing bleeding, any more than is absolutely unavoidable (*Fig.* 400).

The cleansing must be carried into all recesses and *right round* the fragments; it is quite unnecessary, however, and very harmful to the

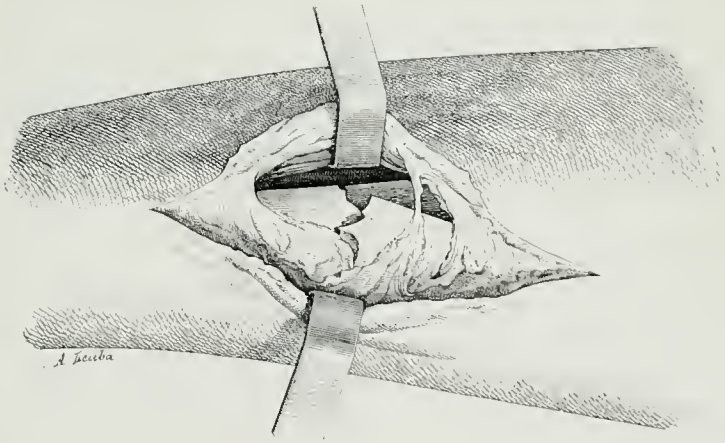


Fig. 400.—Compound fracture of the tibia. The cleansing of the deep part of the wound.

healing processes, forcibly to bend the broken limb, to make the edges of the fracture gape excessively, and to destroy the vascular connections of the two ends of the bone for a considerable length.

Once the cleansing is completed, if the conditions appear satisfactory,

the superficial wound will be closed, a small opening for drainage being left at the lower angle. If the accident is quite recent, the injured area of small extent, and the local lesions slight, the wound may even be sutured completely.

In the opposite conditions, however, it is always prudent practice to leave the wound open more or less widely and lightly packed with a strip of sterilized gauze. Over it a well-padded dressing is applied and carefully bandaged. At the same sitting, **reduce the fracture and immobilize the limb in a plaster apparatus.**

Reduction demands great care, and one must not be content with anything short of exact adjustment of the fragments. If they can be brought together and maintained in good position without trouble, a well-

Fig. 401.—Application of a plaster apparatus with a movable lateral shutter for dressing the wound in a compound fracture.

applied plaster apparatus such as we are about to describe will be sufficient. If not, then direct fixation by sutures, staples, or pegs is necessary (see later).

With regard to the plaster apparatus, in cutting it take care to allow for the thickness of the dressing; if necessary, provide an opening at the position of the wound or fit a small movable splint there, which can subsequently be turned down like the leaf of a table (*Fig.* 401). See that reduction is maintained, and that the limb and foot are kept in good position while the apparatus is in process of drying.

Enlargement of the wound and immediate cleansing of the site of fracture, exact coaptation of the fragments and bone suture if necessary, immediate immobilization in a plaster apparatus: these are, in our opinion, the essential indications in the immediate treatment of compound fractures. I have treated, and have had treated,

a considerable number of fractures by this method; the results which I have seen justify me in recommending it as the method of choice.

Immediate immobilization ought to be considered as essential in these cases, even—indeed especially—in fractures which are already infected, and by plaster alone can real and lasting immobilization be obtained. As to the dangers of gangrene, or other accidents due to compression of a swollen and infiltrated limb, there is little reason to fear them under an apparatus which does not embrace the entire circumference of the limb and which has been carefully applied. Personally, I have seen a leg become gangrenous under a Scultetus apparatus; I have never seen such a complication when a plaster gutter has been used.

Undoubtedly, after a time, the swelling subsides and the limb shrinks, and the plaster case becomes too wide; but it is then a very simple matter to apply a fresh apparatus after having removed the dressing and examined the wound; further, if satisfactory reduction has been obtained at first, only a little lateral displacement will occur, and can be easily corrected.

I may add that immobilization is also the best means of alleviating the pain.

The method of treatment which has just been outlined almost always necessitates general anæsthesia, particularly in cases where there is much overlapping and reduction is difficult; when there is but little displacement, and only opening up the wound and irrigation are required, they may be performed simply with local anæsthesia, or without any anæsthesia at all.

2. **Compound Comminuted Fracture, with large Fragments, without serious Vascular lesions, but with more or less extensive Cutaneous and Muscular lesions.**

In these cases, the wound is large and contaminated, its walls are contused and lacerated, reduction and coaptation of the fragments are difficult, interposition of muscle is common; there is, in fact, from all points of view, quite a difficult task to be undertaken.

Give chloroform or ether, prepare the whole region and the wound as before; enlarge the wound freely, and irrigate it with warm boiled salt solution.

Excise the frayed-out tags of fibrous tissue and the torn strips of muscle which hang here and there; but do not let the desire to get a clean-cut wound lead to doing too much. Remember that these shapeless fragments, although they have retained but little vascular connection, will recover their vitality and play a useful part in the formation of the bone cicatrix.

Above all, respect the bone tissue; remove only the completely separated splinters, or those which have scarcely any attachment and are interposed between the main fragments; separate the little flap of periosteum to which they still adhere without cutting it. Sometimes one will find large pieces of bone completely detached and which simply come away in the hand; they must be extracted, since they are very likely to act as foreign bodies in the wound between the fragments; but after such loss of substance coaptation often becomes very difficult.

The mechanical cleansing and disinfection of the site of fracture form only the first step in the operation; the second must consist in the reduction and coaptation of the fragments, and it is essential that the contact should be sufficiently wide to insure ultimate consolidation.

The necessary coaptation can only be obtained by certain manœuvres, varying according to the character of the osseous lesions, and which will be discussed elsewhere. (See OPEN REDUCTION AND RE-UNION OF FRACTURED BONES.) It is, however, necessary to guard against doing too much and aggravating the injuries to the soft parts and the denudation of the bones in striving to obtain ideal coaptation of the fragments, which even if achieved must in the nature of things be very precarious, since it is very likely to be disturbed during the application of the dressing and the immobilizing apparatus.

The fragments of a broken bone cannot be joined together like the two ends of an inert rod, and no good purpose will be served by the most exact artificial restoration of continuity, if later the sole agent, the "living" callus, which can produce permanent union, is wanting. Continuous extension on the leg, the thigh, or the arm, properly applied and carefully supervised, will give better and surer results than the most persistent attempts to obtain direct mechanical adjustment.

Therefore devote every care to the local cleansing: in all the recesses of the wound, under the stripped-up skin, between the muscles, behind the fragments, and especially between the fragments, where anything that is interposed must be excised or removed. Bring the fragments together as well as possible, and if the wound is large and under suspicion, do not fail to drain it freely. Leave a drainage tube at the lower angle of the incision, make a counter-opening at the bottom of the area from which the skin has been stripped, and place another tube there; do not suture the wound, or at the most put in one or two sutures at the extremities, and place a lightly packed strip of gauze at the centre of the wound, which is often still bleeding. Terminate the procedures by applying a large dressing and, over the dressing, a plaster apparatus put on at once. This operation is one of the commonest and most serious which falls to the lot of the isolated practitioner.

If there is no fever, the first dressing will, as a rule, be left untouched for eight or ten days; the time when complications arise will then be past, and the gauze wick and the drainage tubes may be removed, the position of the limb will be corrected, if necessary, and either the immobilizing apparatus be refitted, or continuous extension applied, as may seem best.

3. **Compound Fracture, Dirty and Infected.**—Up to now we have been considering cases in which the traumatism had occurred quite recently, and in which, although we had considered the wound as infected, and had treated it as such, it was not necessarily so, or at least no signs of local infection had yet appeared.

Quite different are such cases as this:—

An unfortunate navvy was knocked down and dragged along the road. He was brought to hospital. His left leg was bent in two at the middle;

on the inner side two inches of the tibia were projecting through a large tear in the skin (*Fig.* 402) ; the bone was black with dust and dirt ; the wound itself, its edges, and all the inner surface of the leg, were covered with mixed blood and earth.

A terrible accident undoubtedly, when we remember that in such circumstances the least danger which threatens the patient is suppuration at the seat of fracture ; diffuse cellulitis, tetanus, or spreading emphysematous gangrene are only too seriously to be feared.

I have seen the symptoms of emphysematous gangrene burst forth a few hours after an injury of this kind, in the case of a man who had been left untended in the cold, lying on some straw, and after all efforts, in spite of high amputation of the thigh, he died on the following day.

Another example : A woman was brought to us three days after sustaining a fracture of the left leg ; the fracture was compound, it had not been reduced and scarcely even dressed. She had a temperature of 103° ; the whole of the inner surface of the leg was red and œdematous ; the

Fig. 402.—Compound fracture of the leg.

upper tibial fragment showed itself, greyish and dirty, in the wound, and evil-looking, blackish fluid flowed from the cavity.

It was, moreover, a fracture of comparatively simple type ; there were only two fragments, and the soft parts had been but little damaged. Undoubtedly, if it had been properly treated in the first instance, it would have healed without the slightest complication.

What is to be done with these gravely contaminated fractures, which are already infected and inflamed ? The question of amputation naturally arises, and up to comparatively recent times, the answer was almost always —and rightly so—in the affirmative.

To-day—and particularly in the first hypothesis, that of a recent accident—as a rule **we ought not to amputate** ; we ought to perform the following operation, although it is certainly more troublesome, demands much greater attention to minute detail, and takes far longer than any ordinary amputation.

Open up the wound by an extensive longitudinal incision, enlarge it also transversely if it seems necessary, after having thoroughly cleansed

the whole limb with soap and water, and alcohol and ether. The site of injury must be widely exposed and free access provided to its extreme limits.

Then proceed to remove the grosser particles of dirt with a stream of very warm boiled water, and, with the water and sterile gauze, go slowly and systematically over the whole wound, the fragments, the soft parts, the deep surface of the skin ; one by one, each bit of bone, each muscle, each flap of tissue will be examined and cleansed. It is a work requiring patience and persistence.

If the protruding fragment of bone is very dirty, widely stripped of periosteum, or already dry, then excise it, or at least, with saw, gouge-forceps, or chisel, cut away its extremity and the cortical layer from its inner surface, and fashion it into a wedge ; shape the other fragment in the opposite direction, so that good broad surfaces can be brought in contact.

After these preliminary steps, inundate the whole wound with a solution of hydrogen peroxide. I shall have to refer frequently to the use of this valuable agent, and later on shall quote cases showing its usefulness. With a compress soaked with the solution wipe over the entire surface. Lastly, in such conditions it is out of the question to think of any elaborate measures for securing exact adjustment or any method of mechanical re-union of the bony fragments ; reduce the fracture as well as possible, and leave everything open, placing drainage tubes in suitable positions and packing the wound lightly with gauze. After that, immobilize the limb.

It is the local and general infection which must be combated first of all by these open methods ; later, when the danger is past, special measures will be required to get sound bony union ; and towards this object much will have been done if suppuration is averted.

When infection is certain and inflammation has already set in, the same line of treatment should be followed, but the chances of obtaining good results are decidedly less ; still, one should never resort to amputation in these cases when the bone lesions are reparable and the soft tissues not extensively damaged, unless danger to life is threatening, or the local symptoms are intractable and extending.

4. **Compound Fracture into a Joint.**—In the foot, such an accident is not uncommon ; it is always serious, but the prognosis varies —and the immediate treatment must also be modified—according to the gravity of the lesions, and also according to the date of the injury and the state of affairs with regard to infection.

Take for instance, a case of Dupuytren's fracture with an extensive laceration of the skin over the internal malleolus, which is broken transversely and torn away from its attachments ; between the two malleolar fragments, the cartilages covering the astragalus and the lower articular surface of the tibia can be seen.

Such an *articular wound* should be treated like an *abdominal wound* ; there must be no hasty, blind exploration with a dirty finger or dirty instruments and without proper aseptic preparation.

An open articulation must not be touched until everything is ready for carrying out the necessary reparative measures. Inspection alone, or the slightest amount of palpation, will give all the information that is required; any immediate exploration of the wound can supply nothing more, and would simply introduce fresh dangers.

If the patient must be moved, and if no resources are available at the scene of accident, **on no account must the wound be plugged** with a handkerchief or any similar article which may be at hand; if there is much bleeding, the upper part of the leg will be encircled with an improvised tourniquet, the wound simply covered up, and the limb fixed between two splints, fashioned on the spot (*Figs.* 403, 404).

It must be clearly recognized that in these compound fractures the future of the limb, and often the life of the patient, are decided by the first dressing.

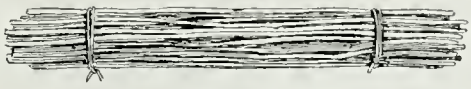


Fig. 403.—Splint improvised with a bundle of sticks.

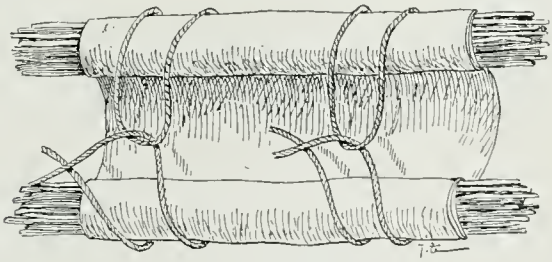


Fig. 404.—Improvised transporting apparatus.

The whole foot and the lower part of the leg having been carefully cleansed with soap and water and disinfected, and the surgeon's hands properly prepared, the site of fracture and the joint cavity are irrigated with very warm boiled water; the fragments will be everted, so that the space between them and all recesses can be washed out and cleansed; all foreign bodies, little splinters of bone, and clots, will be removed.

In the condition which we have taken as an example, the extent of the damage to the tissues is as a rule very limited, and after the cleansing is completed the bones will be reduced, the wound left widely open with one or two drainage tubes at its angles, a large external dressing applied, and the limb immobilized forthwith.

The situation is more difficult in the case of a comminuted articular fracture, **a crushing injury of a joint**, even when the accident is quite recent and when infection—though certainly to be feared—has not rendered itself evident.

Begin with free irrigation with warm water ; enlarge the wound longitudinally, and do not hesitate to make a second incision if it seems necessary for adequate access to the joint cavity. It is of the utmost importance to determine at once the exact condition of the articular surfaces, so that appropriate measures may be adopted without delay.

If, at the elbow or ankle for example, several large fragments, displaced and overlapping, are found, an attempt will be made to disengage them and to restore their normal relationships, and sometimes it will be possible to reconstruct the joint surfaces very accurately. **Bone suture,** or better, **pegging**—if the means are available—almost always form the indispensable complement of these conservative measures.

Sometimes the epiphyses, one of them at least, are broken into numerous fragments of all shapes and sizes, and the irrigating fluid washes away quite a quantity of bony scales and splinters, while others remain attached merely by slender strips of periosteum or capsule.

It is quite hopeless to think of reconstructing an articular extremity out of such débris ; still, do not remove the fragments before ascertaining that they are quite useless. If they cannot be used, then they must be removed, the joint cavity cleared out, and the broken epiphyses trimmed and modelled with the gouge-forceps ; in fact an atypical and economical resection will be performed. In dealing with the foot, an effort should be made to preserve the malleoli, or at any rate two lateral processes, to serve as buttresses for the foot and to help to prevent it from being inverted or everted.

After these operations, bilateral drainage is of course essential, combined with light packing by means of a strip of aseptic gauze if there is much oozing.

In the case of a compound articular fracture which has been untreated or badly treated, and which is found infected and inflamed, with redness and œdema of the limb, fever, etc., the prognosis is very serious.

In some of these cases **amputation** may become necessary as a last resource (see later), but it should never be resorted to except under the pressure of immediate vital necessity. Open the joint freely on both sides, irrigate it, clear it out, extract any loose fragments of bone, and wash it out thoroughly with a solution of hydrogen peroxide, put in neither sutures or gauze packing, but place two large drainage tubes, one on either side of the joint, right to the bottom of the cavity ; that is all that should be done at the time. A large external dressing will be applied, and the limb immobilized. It is not the fracture nor the subsequent union of the bones, nor the future usefulness of the joint, which requires attention ; it is the infection, the septic osteo-arthritis, which must be combated and checked.

A set typical resection is scarcely to be recommended in such circumstances ; the indications for it will rarely arise. Portions of the bony extremities may be excised if necessary to insure perfect drainage of the joint recesses and the infected area, but any more extensive measures should be deferred until such time as the infection has subsided.

OPEN REDUCTION AND REUNION OF FRACTURED BONES.

We have already said that in certain subcutaneous, irreducible fractures, open measures and direct reduction may be necessary; we have also seen that, in compound fractures, exact and stable coaptation of the fragments constitutes the second step in the necessary operation, and sometimes entails rather difficult manœuvres and, finally, suture or some other method of mechanical reunion.

It is advisable to study closely the technique — always rather troublesome — of **artificial reunion of bones**, taking certain general types, from amongst the many special forms, into consideration.

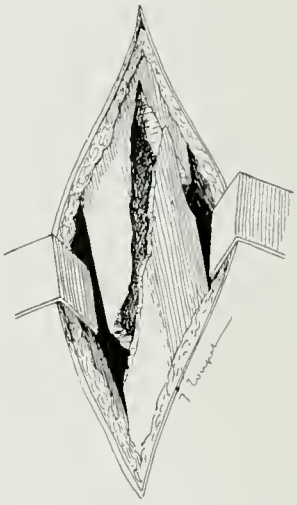


Fig. 405.— Very oblique fracture.

(*A*). There are only **two principal fragments**, but they are so **oblique and sharp-pointed** (*Fig.* 405) that **exact adjustment is very difficult, and maintenance in good position practically impossible.**

By longitudinal traction in the axis of the bone, combined with adequate counter-extension, it will be possible to disengage the sharp points of the fragments from the muscles in which they are embedded, and to bring the fractured surfaces together in good position.

If, however, the two surfaces are so oblique and so regular that the fragments become displaced again as soon as the traction is relaxed, it becomes necessary to fix them by one or two well-placed sutures or by a ligature (see later).

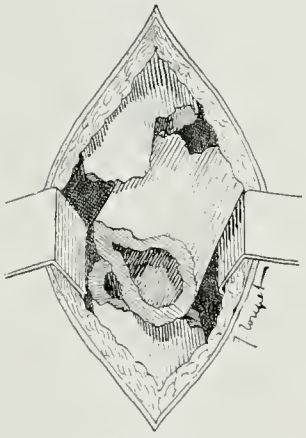


Fig. 406.— Comminuted fracture with an intermediate fragment turned crossways.

(*B*). **Two principal fragments, with a large intermediate fragment**—sometimes several—**inverted, placed crosswise** (*Fig.* 406), perhaps with one of its extremities dislocated from between the two chief fragments. Such a condition is not uncommon in fractures of the tibia and clavicle. What is to be done?

If the fragments are reduced as completely as is possible by external manipulations alone, and then things are left as they are, a pseudo-arthrosis, or at any rate very long-delayed union and great deformity, will certainly

result. It is absolutely necessary to restore the longitudinal continuity of the bone by coapting, not the periosteum-covered surfaces, but the naked fractured surfaces.

Efforts must therefore be directed to disengaging and accurately adjusting the interposed fragment or fragments; free access is essential to success, and there should be no hesitation in prolonging the cutaneous incision, since the future functional usefulness of the limb depends on the results of the operation.

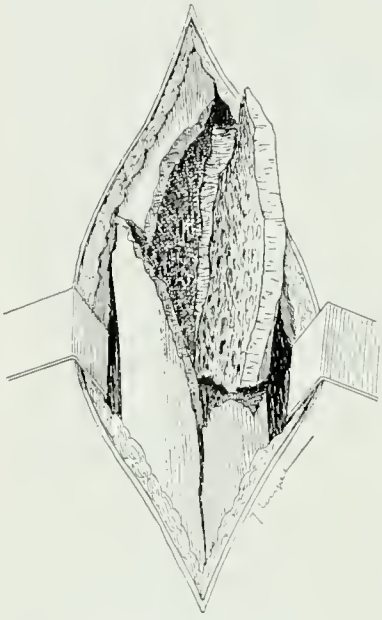


Fig. 407.—Comminuted fracture with multiple fragments.

It may be that the intermediate fragment is almost completely separated from its attachments, and the planes of fracture are so inclined that it slips down and becomes displaced by its own weight; in such conditions pegging is a very valuable resource.

(*C*). Another condition: **the bone is broken into many fragments,** of various forms and irregular outlines; the fragments are found separated from one another (*Fig.* 407), but still retain their periosteal attachments, and by fitting them together the comminuted bony segment can be restored. Care is required in fitting the fragments together, but sometimes when it is completed the interlocking is so close that the external plaster apparatus is in itself sufficient to maintain them in position.

Fairly often, however, a bond of union is indispensable; it is particularly in cases of this type, where it is necessary to bind a group of fragments together, that bone ligature is most useful. In this way we have succeeded on several occasions in building up fractured clavicles and tibias.

(*D*). Lastly, here is another condition which is not at all uncommon in extensive comminuted fractures: a considerable number of isolated splinters have been found, one or more fragments, completely separated from their vascular connections, have had to be removed; as a result there is **a definite loss of substance, of variable extent, in the continuity of the bone** (*Fig.* 408), and there remain only two narrow, pointed fragments, which can merely be brought in contact by one border, or by an area of such limited extent as to be quite incapable of producing a sufficiently strong bond of union.

Never be satisfied with any such incomplete adjustment, under the

supposition that the natural processes will fill up the gap and produce a strong and adequate callus. The hoped-for result will not be obtained, and later, after many months perhaps, it will be necessary to attempt to secure bony union by some secondary operation, which will always be more difficult and more uncertain than any measures undertaken at once, while the nutrition of the bones is good and the muscles are healthy and not contracted or sclerosed.

Examine the two fragments carefully, and see what steps must be taken to get good *broad contact* between them. Naturally, in such circumstances, it is quite impossible to formulate a definite technique; still, one of the following plans will often be applicable.

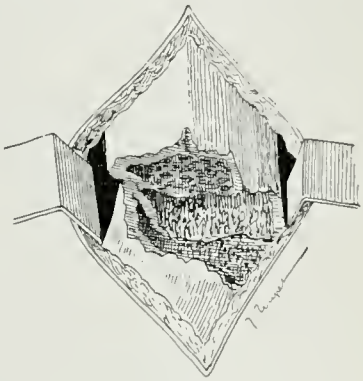


Fig. 408.—Comminuted fracture with loss of bone substance.

If the two points are not on the same side of the bone, it may be possible, after having cut the tips off squarely, to bring the two fragments together, fitting the square-cut extremities into recesses cut to receive them in the corresponding side of the opposite fragment.

Sometimes one of the extremities may be cut in a fork, or a groove may be hollowed out on one of its surfaces, and the other extremity, trimmed, if necessary, fitted into the fork or groove.

Lastly, if the extremities are very slender and tapering, it will often be best simply to resect the points and to place the two terminal surfaces of the fragments in contact. This of course involves more or less shortening of the limb; but firm and regular union is certainly worth some amount of shortening. If the opposed surfaces are somewhat oblique, it may suffice simply to adapt the two fragments together; in other conditions, it will be necessary to resort to sutures, staples, or pegs, to retain them in contact.

This shaping of the fragments is not always a simple task, more particularly as care must be exercised to avoid stripping the periosteum from the bones if good results are to be obtained. A good gouge-forceps is the best instrument for these limited excisions, but Larrey's saw or gouge and mallet will serve equally well if properly handled.

It has already been pointed out that it is necessary to respect the periosteum—even the tags of periosteum—and all the tissues hanging to the bones; and it is also necessary to be sparing with the bone tissue itself. But, though a fractured femur, tibia, or humerus is not to be treated as if it were a piece of inert material, and though nature plays a great part in the reparative processes, there are nevertheless certain mechanical conditions which must be fulfilled if satisfactory results are to be obtained.

Place the fragments in broad contact, that is the first point; **assure the permanency of the contact**, that is the second, and equally important.

To achieve the second part of the programme, immobilization in plaster is not always sufficient by itself, and it is necessary to employ one of the various methods of mechanically reuniting the bones: **suture, ligature, staple,** or **peg.**

Fig. 409.—I. Championnière's drill.

Bone Suture.—Strong silver, platinum, or aluminium-bronze wire, and an instrument for boring the bones, are required. In very exceptional

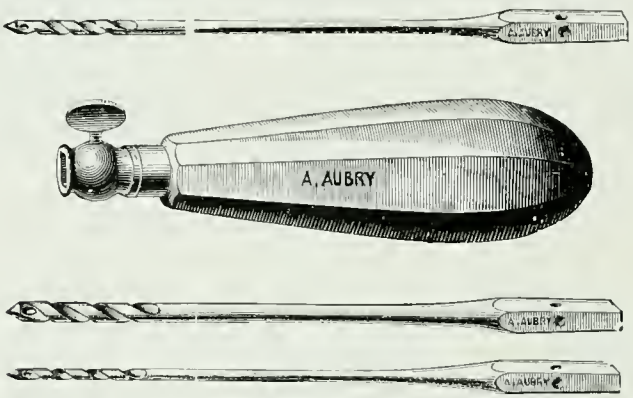


Fig. 410.—Hennequin's drills. The drills are in three sizes, fitting the one handle.

circumstances, if wire is not at hand, or again, when the fragments show no great tendency to become displaced and little support is needed, strong silk may be used.

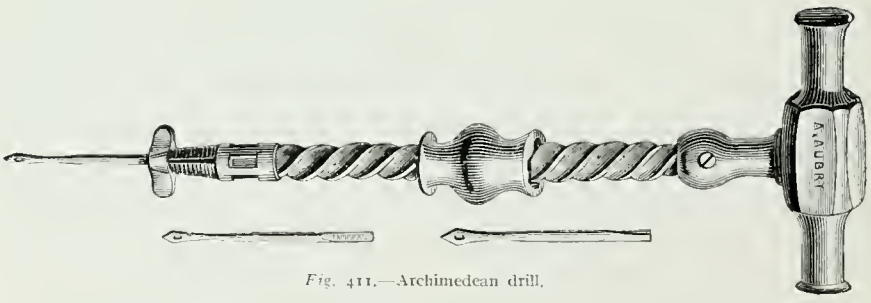


Fig. 411.—Archimedean drill.

There are many good models of bone-drilling instruments (*Figs.* 409, 410, 411); Championnière's drill, a simple awl with an eye near the point,

suffices for all purposes; if need be, an ordinary gimlet will do all that is required.

The important thing is to use the instrument properly; the point must be applied perpendicularly to the surface of the bone, which again must be firmly supported from below by a retractor or the handle of a suitable instrument placed underneath it, and which at the same time serves as a protector to the underlying soft tissues. Tuffier's bone-holding forceps, shown in *Figs.* 412 and 413, are extremely useful for raising, fixing

Fig. 412.—Tuffier's angled bone-holding forceps.

and adjusting the fragments. Care will be taken to lay the bone bare at the point where it is to be drilled, by incising and slightly retracting the periosteum, to prevent the tags of tissue becoming twisted around the point of the instrument and interfering with its action.

The suture, to be really useful, must be placed **in good position and in the proper direction as close as possible to the line of fracture.**[1]

If the line of fracture is transverse, a single lateral suture will give only very doubtful security (*Fig.* 414), as the two fragments will very

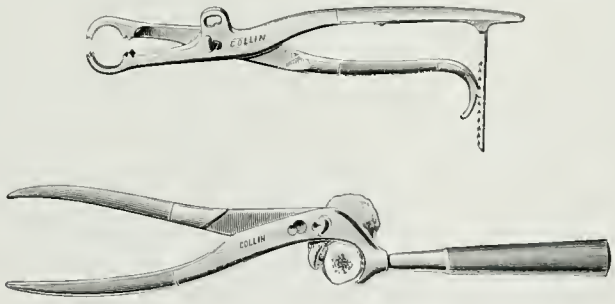


Fig. 413.—Other models of Tuffier's bone-holding forceps.

probably move on it as on a hinge; adequate fixation requires two sutures, or a perforating suture such as is represented in *Fig.* 415.

It is the same with an oblique fracture (*Fig.* 416), except in the cases where interlocking notches provide additional support.

Further, the suture must always be placed **at right angles to the line of fracture**; otherwise it will prevent neither slipping nor lateral inclination of the two extremities.

[1] Tuffier, with good reason, insists on this last point; further, we believe with him that too much is not to be expected from the suture, and that the operation is not "a simple and easy matter." "Réduction des fractures et radiographie," *Presse médicale*, 10 janvier, 1900.

Due care must therefore be taken to bore the holes in good positions; the wires are then passed, and before they are tightened, the fragments will be reduced and maintained in exact apposition. The two ends of the wire are first drawn tight and held closely applied to the surface of the bone,

Fig. 414. — Transverse fracture. A single lateral suture; *bad.*

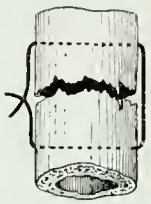


Fig. 415. — Transverse fracture. Suture traversing the whole thickness of the bone; *excellent.*

Fig. 416.—Oblique fracture. Suture not perpendicular to the line of fracture; *bad.*

Fig. 417. — Oblique fracture. Double loop suture, perpendicular to the line of fracture.

then slowly twisted until the two fractured extremities are bound together firmly and accurately. The ends are then cut short and turned down in contact with the bone, and care is taken to bury them under the periosteum and the neighbouring fibrous tissues.

Bone Ligature.—Ligature is indicated when it is necessary to reunite two long, oblique and pointed fragments, or to bind together a group of small pieces. It may be employed alone as a simple ring encircling the bone, or combined with suture. The first method certainly does not give very great security, but it is sometimes useful as a supplementary measure.

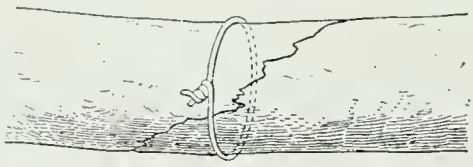


Fig. 418.—Simple ligature, at right angles to the long axis of the bone (*bad ligature*).

Take for instance two long, oblique tibial fragments which have just been brought in contact and adjusted; to keep them in position they may be encircled with a tight circular ligature, placed in good position at the point where separation shows the greatest tendency to recur, perpendicular to the plane of fracture (*Fig.* 419) and not to the long axis of the bone (*Fig.* 418). Several turns of thick and strong silk will sometimes suffice; on several occasions we have thus repaired, as one might a broken stick, a fractured tibia or clavicle.

A Cooper's or Deschamps' needle or a pair of forceps will serve to pass the thread around the bone without causing any damage; the first ligature

is passed and tied, and then the thread is passed two, three, or more times around the bone, care being taken that all the turns are parallel, close together, and as tight as possible. Still, we must repeat, this is only an accessory procedure, which by itself is usually insufficient.

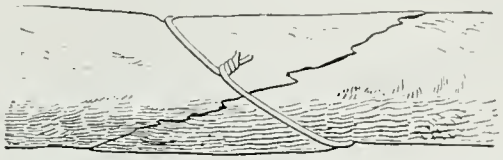


Fig. 419.—Simple ligature, perpendicular to the line of fracture, and prevented from slipping by two notches cut in the bone.

Another and more secure circular ligature is the following; a heavy silver wire is passed around the bone perpendicularly to the plane of fracture, and a notch is cut on the surfaces of each of the two fragments, to receive it and prevent it from slipping (*Fig.* 419); it only then remains to

Fig. 420.—Dollinger's ligature.

twist the ends of the wire tightly together after having verified the position of the bones.

We need merely mention Dollinger's method (*Fig.* 420); it consists of two circular ligatures, bound together by two longitudinal loops.

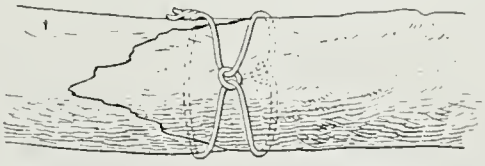


Fig. 421.—Senn's ligature (Staffordshire knot).

The best ligature, however, is **the transfragmentary chain ligature** recommended by M. Hennequin: a hole is bored through the two fragments perpendicularly to the plane of fracture, and through it a double wire is passed (*Fig.* 417), the two ends are carried round, one on either side of the bone, passed in opposite directions through the median loop, then drawn tight and twisted.

Or again, the median loop may be cut and the two pairs of ends simply carried round the opposite sides of the bone and twisted, each pair separately. A simple circular ligature is sometimes useful as an additional safeguard when the line of fracture is very oblique (*Fig.* 422). *Fig.* 421

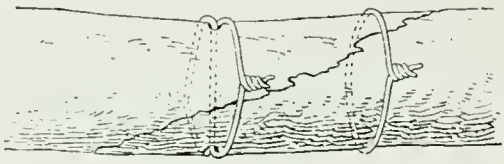


Fig. 422.—Double chain ligature; supplementary simple ligature

shows a method of reunion of somewhat similar type. Lastly, suture and ligature may be combined, as shown in *Plate IX.*

When there is abundant room, or when it can be provided, absolutely immovable union can be obtained by means of the double ligature which we have ourselves described and have several times employed.

Figs. 423–5 show very well the manner of its application. Two holes are bored perpendicularly to the plane of fracture and close to the ends of the fragments; a loop of wire is taken, and one of its ends passed through each of the orifices. That is the *first step* (*Fig.* 423). The

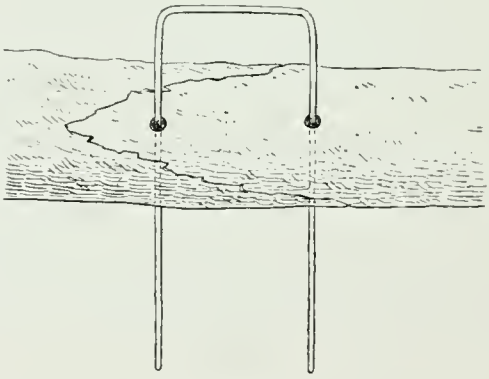
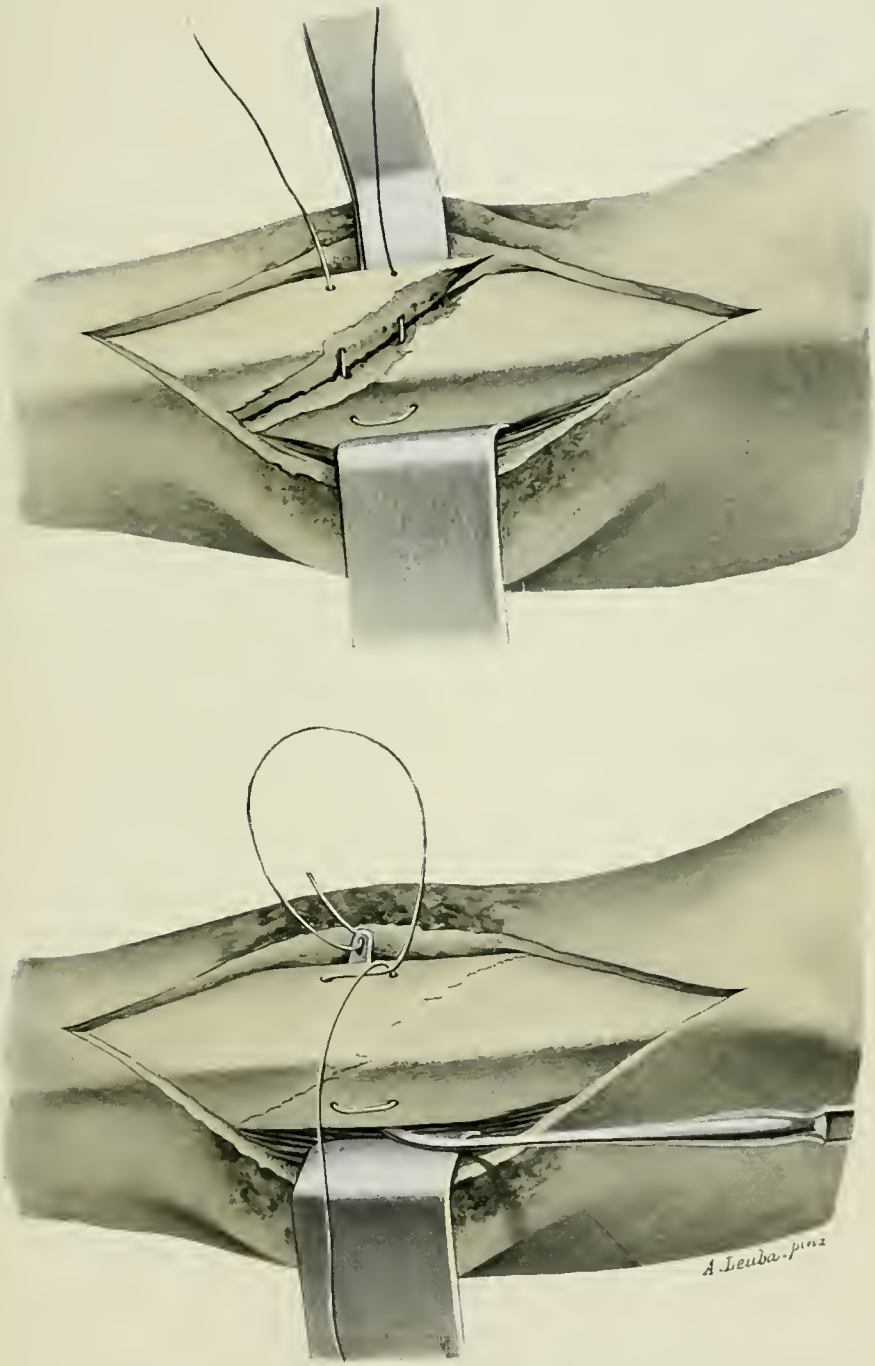


Fig. 423.—Lejars' double ligature (1st step).

median loop is bent and carried round in contact with the bone to its opposite surface, where the free ends of the wire emerge. These free ends are now passed through the loop, drawn tight, and then carried round the bone on the side opposite to that on which the limbs of the loop lie. This is the *second step* (*Fig.* 424).

Plate IX. Bone Suture. Suture and ligature combined. In the upper figure, the loop of wire passes through the two fragments. In the lower figure, one of the ends is carried round under the tibia from without inwards, and will be twisted with the other end.



SUTURE OF BONE

Lastly (*third step*) each of the two ends are passed in opposite directions under the limbs of the loop where the latter emerge from the upper pair of holes, and are twisted together (*Fig.* 425).

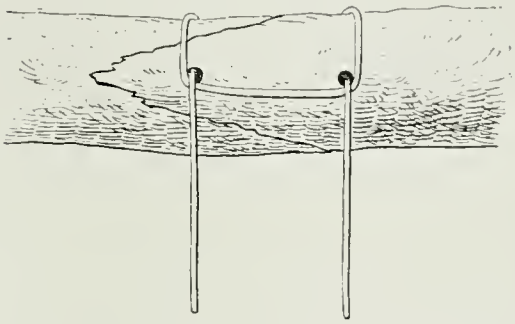


Fig. 424.—Lejars' double ligature (2nd step). The bone is seen from behind; the upper loop has been passed below and behind the bone, and the two free ends of the wire brought through it.

The arrangement therefore consists, in a way, of two circular ligatures and two longitudinal loops, all bound firmly together. Fixation is absolute in all directions. But as I said just now, it is necessary to have sufficient

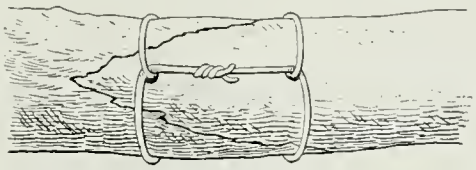


Fig. 425.—Lejars' double ligature (3rd step).

room to get fairly easily round the bone, and the wire must be strong, as it is apt to break at the bends.

Reunion of Bone by Staples.—With Jacoël's[1] or Dujarier's staples, this method is well worthy of recommendation,[2] and a certain number of the staples of various sizes may with advantage be included in the equipment for dealing with urgent conditions. The points bear a series of notches like those on the cramps used by carpenters, which enable them to penetrate the bone without splitting it (*Fig.* 426).

In using them, the following rules will be observed: The staples must always be placed at right angles to the line of fracture; this is of course

[1] Jacoël, Agrafes osseuses, *Presse médicale*, 25 déc., 1901, and 25 fév., 1903. Ch. Dujarier "Traitement des pseudarthroses par l'agrafage métallique," *Presse médicale*, 15 nov., 1902, p. 1099. See also Guibal, *Le traitement sanglant des fractures de jambe (fractures obliques) fermées et récentes*, Thèse doct., Paris, 1903.

[2] Quén[illegible], Traitement des fractures de jambe avec les agrafes de Jacoël, *Bull. de la Soc. de chir.*, oct., 1902

only an application of the general rule already formulated. The fragments having been adjusted, the positions which will correspond to the points of the staples when the latter are properly placed are carefully determined, and at each of these spots a small hole is bored with a fine drill—it is of the greatest importance that the distance between the corresponding holes should be exactly equal to that between the points of the staples. The staple is then applied, its two points being placed in the holes which have just been prepared for them; and is then driven home with a mallet by gentle taps delivered directly over each of its points alternately, until the cross-piece is embedded in the bone and forms only a very slight elevation above the surface. If necessary, the whole procedure can be quite well carried out without any special instruments, but it is much more convenient to use a small special drill, a metal mallet, and a punch, by means of

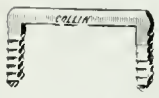


Fig. 426.—Jacoël's bone staple.

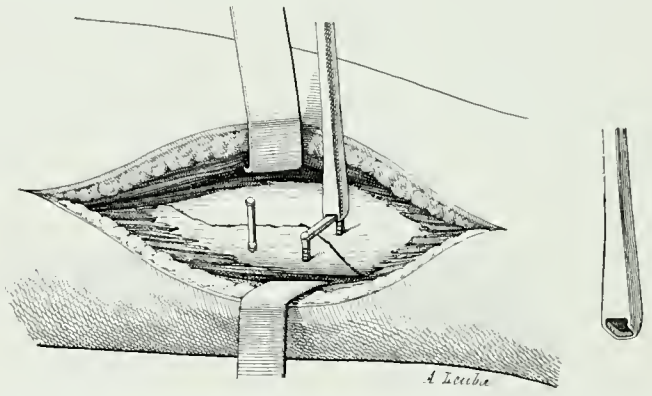


Fig. 427.—Reunion of an angular fracture by means of bone staples. The first staple is in position; the second is being driven home with the help of the punch represented on the right. (Dujarier's staples.)

which the blows of the mallet can be accurately directed against the angle of the staple (*Fig.* 427).

A single staple is sometimes sufficient, but more frequently two, or even three, appropriately placed, are required.

Bone Pegging.—Pegging is always a rather difficult matter, and as it involves the possession of special appliances, the indications for its application are comparatively limited in urgent surgery.

The pegs are made of various materials: of ivory, of calf-bone, cut out of the compact bone and sterilized, and of decalcified bone. The last are best prepared for use by immersion in ether to remove the fat, and boiling for three-quarters of an hour in strong carbolic solution, and are stored in alcohol until wanted.

Lane[1] uses plated steel screws, which he embeds in the fragments

[1] Quoted by Dujarier, *Traitement sanglant des fractures de jambe récentes*, Thèse de doct., 1900.

after coaptation, and which assure perfectly firm union ;[1] ordinary screw nails might be used after careful sterilization, but they would have the disadvantage of rusting in the tissues.

The pegging may be **transfragmentary or central.** In treating an oblique fracture (*Fig.* 428) two holes will be bored transversely through the fragments after they have been accurately adjusted, and in each of the holes a peg is introduced and steadily driven in by gentle taps with a mallet.

The two fragments thus fixed are in perfect contact, and all that remains to be done is to unite the periosteum over them in the best manner possible, to close the wound completely or partially, according to the conditions, and to apply the plaster apparatus, the two extremities of the limb being steadied with the greatest care during all the manipulations.

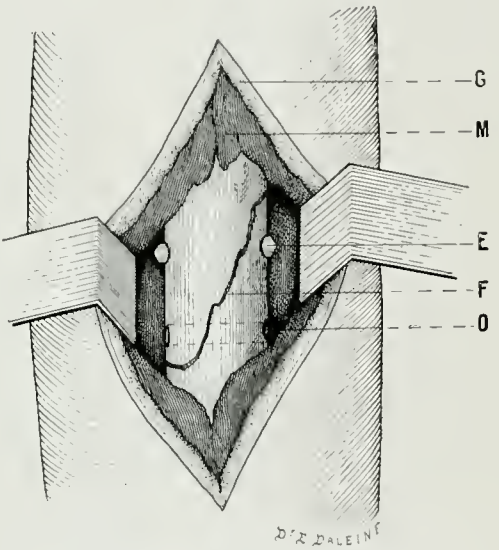


Fig. 428.—Transfragmentary pegging. (G) Subcutaneous tissue; (M) Muscle; (E) 1st peg.; (F) Line of fracture; (O) Hole bored through the two fragments for the reception of the 2nd peg.

This method has also given very remarkable results in certain *multiple fractures involving joints*, such as fractures of the lower end of the humerus, supra- and intercondyloid (T-shaped fracture) ; it is to this type of epiphyseal fractures that pegging is particularly applicable. The condyle, the trochlea, and epitrochlea are bored transversely, and a long peg (B, *Fig.* 429) forced into the channel binds the separated segments together ; a vertically placed peg (A, *Fig.* 429), fixing the trochlea to the shaft of the humerus, completes the work.

Of course it is essential that the pegs should fit tightly into the holes bored for their reception, and that they should traverse the bone from side to side, to exercise their most useful effect. The protruding extremities of the pegs are resected a little way from the surface of the bone.

When the fracture is transverse, or only slightly oblique, and after the transverse modelling of the fragments of which we have already spoken, it may sometimes be possible to employ the method of **central pegging** ; the peg being introduced into the central canal of the two ends, and so acting as an axial support.

This intra-medullary peg ought to be large enough to fit the central

[1] Lane's observations show that these metallic screws are quite well tolerated by the tissues (see the radiographs reproduced in Dujarier's thesis).

canal fairly tightly, and long enough to prevent any lateral inclination or tilting of the fragments after they have been restored to position, and should always extend an inch at least on either side of the plane of fracture. The technique of central pegging is not always devoid of difficulty. By lateral inclination of the limb, the fractured surface of the lower fragment will be made to present in the wound. The peg is then introduced into the medullary canal, by gentle strokes of the mallet, as far as is necessary. When that has been effected, the lower segment of the limb is grasped firmly and drawn downwards and laterally, until the upper end of the peg can be entered into the opposite portion of the medullary canal, and then the two segments of the fractured bone are pressed firmly together.

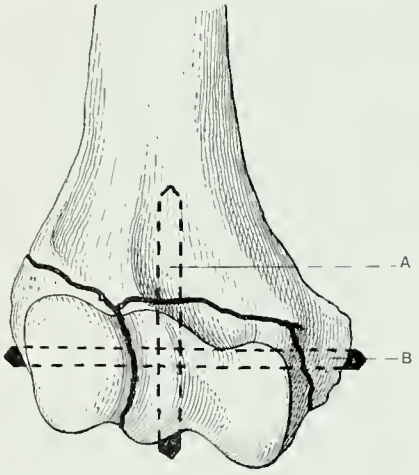


Fig. 429. Cross pegging of a T-shaped fracture of the lower end of the humerus. (A) Vertical peg fixing the trochlea to the humerus. (B) Transverse peg.

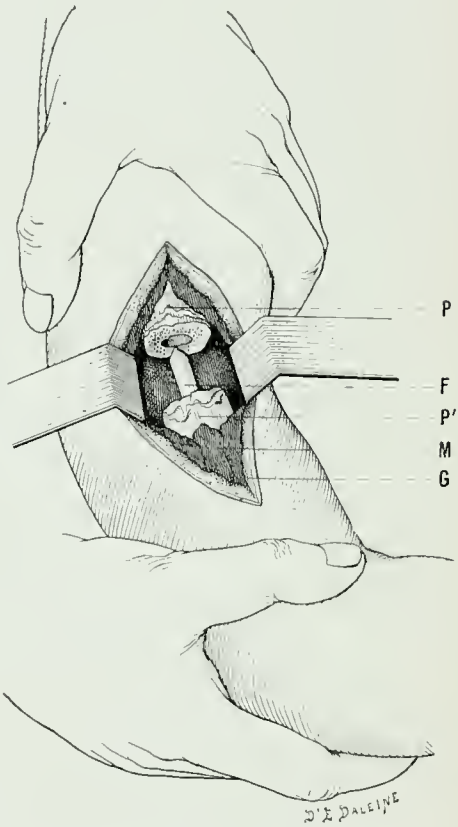


Fig. 430.—Central pegging of a fracture of the humerus. The introduction of the peg into the upper fragment. (P) The upper fragment. (F) Peg. (P') Lower fragment. (M) Muscle. (G) Subcutaneous tissue.

Fig. 430 shows very well the position and the manner of using the two hands in this manœuvre ; a good deal of pressure with the right hand in the axis of the limb is required to complete it, and, if need be, a few blows may be given with the palm of the hand or a padded mallet, very carefully and always in the long axis, on the lower extremity of the limb (elbow, knee, or heel, as the case may be).

Once the pegging is finished, the periosteum is sutured (*Fig.* 431) as before and the same precautions are taken during the application of the immobilizing apparatus, lest any sudden movement should break the

inter-fragmentary bond of union, and in a moment destroy all the results of the foregoing work.

When a considerable amount of bone tissue has been lost, and it is very difficult or impossible to bring the two fragments into contact, a peg may even be used to bridge over the gap. Gaudard has reported two cases treated in this way, followed by satisfactory union;[1] in both cases, however, the patients were young, and in such circumstances the plastic power of the periosteum is a very important factor.

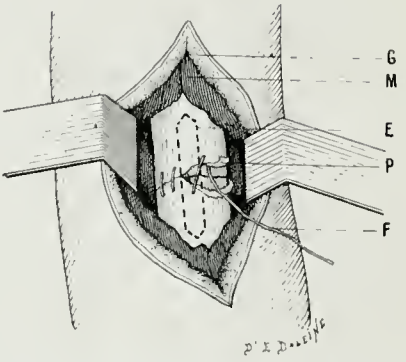


Fig. 431. — Central pegging. Suturing the periosteum. (G) Subcutaneous tissue. (M) Muscle. (E) Peg in the medullary canal of the two fragments. (P) Periosteum. (F) Continuous suture uniting the two edges of the periosteum.

A long and thick peg is fixed firmly in the two portions of the medullary canal; then, in the gap between the fragments, the periosteum is carefully closed over the

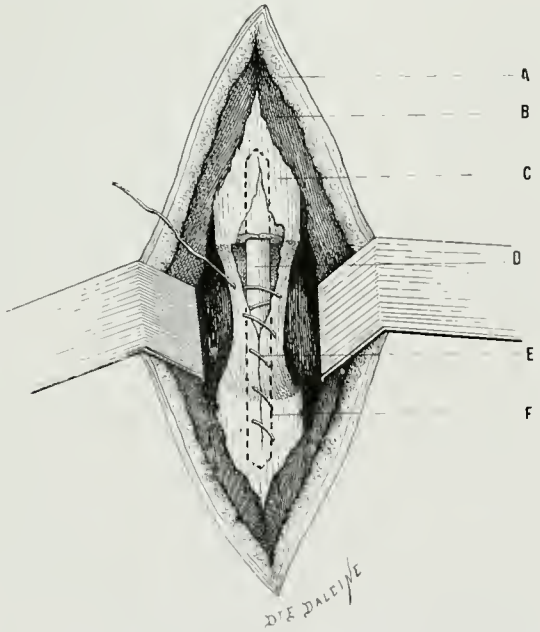


Fig. 432. — Central pegging of two fragments which cannot be brought together. (A) Subcutaneous tissue. (B) Muscle. (C) Upper fragment. (D) Peg bridging the gap between the two fragments. (E) Periosteum sutured around the peg. (F) Lower fragment.

exposed portion of the peg by a continuous suture of catgut (*Fig.* 432).

[1] Gaudard, *Sur les chevilles d'ivoire comme moyen d'immobilisation directe des fragments osseux et comme soutien du périoste*, Thèse de Genève, 1892.

The new bone which ultimately fills up the gap between the fragments is derived from this periosteal covering, and naturally the ultimate results will be very doubtful if the periosteum itself has been lacerated or destroyed by the primary injury.

EXTENSIVE CRUSHING INJURIES.

The treatment of these conditions constitutes one of the gravest and most pressing problems in urgent surgery; it is one regarding which every practitioner should have clear and well-defined views, because it is one which may present itself suddenly, and in such conditions that he must deal with it alone.

Before all things to save the patient's life, and, whenever possible, to save the limb, or at least to restrict the sacrifice of tissue to what is absolutely unavoidable: that is the guiding principle which ought to govern the decision, which must be made without delay; it expresses the two great indications to meet which every effort must be directed.

It is useful to distinguish between **the crushes affecting a limb in its continuity**, which involve a limited segment at some level in the length of the limb—the thigh or the arm, for example,—and **the peripheral crushes** affecting the foot or the hand, and extending upwards for a variable distance.

I. Crushes in Continuity.

Case 28.—A carter, some 40 years of age, was brought into hospital; some hours previously he had fallen under his cart, and one of the wheels had passed obliquely over the upper third of his right arm. At that level the skin presented merely a longitudinal wound one or two inches in length, from which a little dark blood was oozing; but below the skin, and for a length of four inches at least, the limb seemed to be transformed into a pulp; under the cutaneous covering one felt only a soft crepitating mass which slipped under the fingers; in all this zone the arm presented a deep circular groove, which gave it a spindle-shaped appearance. The rest of the limb was pale, comparatively cold, practically without sensation and without movement; but above the elbow the pulsations of the brachial artery could be felt; at the wrist the radial artery also could be felt pulsating, though feebly. The great vessels appeared to be intact, and that was a more than sufficient reason for attempting to save the limb. The injured region was therefore freely opened up, carefully irrigated with warm boiled water, which washed away the clots, the splinters of bone, and the muscular débris, and the wound lightly packed with iodoform gauze; then the limb was enveloped in a thick layer of wool and a plaster gutter over all assured immobilization. Nothing more was done; the damage to the bone was too extensive, the vitality of the limb was too doubtful, and I may add, the patient's general condition was too bad, for any other reparative measures to be indicated. Next day the pulse was better, the skin of the hand and forearm was warmer, movements of the fingers and wrist were possible; at the end of some days, the limb below the injury had completely recovered its vitality, and the crushed area remained free from any signs of sepsis.

It still remained, in the future, to solve the second part of the problem : to restore the osseous continuity of the limb. This is an object which it is often very difficult to attain, and experience shows how very common *pseudarthroses* are, after injuries of this kind in which conservative measures have succeeded. Ultimate success is only to be gained by the exercise of great patience and by means of complex reparative operations. The immediate indications are nevertheless perfectly clear, and we have here, therefore, a first type of crushing injury in which conservative measures are necessary.

1. **Crushing of Bone, complicated by more or less extensive damage to the soft Tissues, but without lesions of the large Vessels.**—During the first few hours the limb remains in a state of insensibility, and often presents all the appearances of death ; it is cold, insensible, and inert, the radial pulse is scarcely perceptible, but on exploring the arteries of the limb more closely, it is found that the pulsations are still present below the crushed segment along the principal artery and its chief divisions. That is a definite sign which indicates that an attempt must be made to save the limb, notwithstanding the extent and evident gravity of the lesions.

The immediate treatment under such conditions must be limited to the very thorough cleansing and disinfection of the injured area, the cutaneous wound being enlarged if necessary, enveloping the limb in a large dressing and immobilizing it in the best manner possible without causing any compression.

The immobilization of these flaccid limbs prevents kinking and stretching of the large vessels, and so favours the restoration of complete vitality in the peripheral segment and cicatrization in the injured area.

When the bone damage is less extensive and the bone is broken into large fragments, some immediate reparative measures by means of suture or pegging may be good practice if the general and other local conditions permit.

Case 29.—In this way I was able to save the right arm of a young man, 19 years of age, who had been caught by a driving belt. The arm was crushed in its middle part ; through a large lacerated wound, surrounded by an extensive area of skin separation, the torn muscles could be seen and the two ends of the humerus projected, with numerous splinters lying between. Three inches below the elbow there was a similar injury of the forearm. But the radial artery pulsated normally, and the large vessels of the limb appeared to have escaped injury. The patient was anæsthetized, and after scrupulous disinfection of the whole limb I set myself to try to repair the chief lesions. In the arm I sutured the two principal fragments of the humerus and brought the musculo-aponeurotic layers together ; in the forearm I pegged the radius and ulna, and also sutured the lacerated muscles layer by layer, and finally immobilized the limb in plaster. After some complications the patient made a complete recovery, with an arm which was sufficiently useful to enable him to work.

These cases occupy an intermediate place between the ordinary compound fractures and the crushes properly so called.

2. **Crushing Injuries in the continuity of a Limb, with serious lesions of the great Vessels.**—Here there can be no doubt as to the condition of the peripheral segment; no pulsations can be felt, and below the seat of injury there is the complete inertia and immobility, the coldness of death. The limb is lost; what are we to do with it? Excluding certain urgent conditions due to sepsis, of which we shall speak immediately, primary amputation or disarticulation is to be deprecated. The gravity of these immediate operations which add injury to injury, during the period of initial shock, or even in the succeeding stage of diminished resistance, is too well known; and further, **by amputating at once, through living tissues, one always sacrifices too much.**

There is then one point definitely established: **no immediate amputation or disarticulation.** Is it necessary, however, to retain the dead segment, to embalm it, and to leave it attached to the upper extremity of the limb until it is detached by a process of natural separation? We do not think so; we can see no advantage in this, but only certain undeniable risks and pains, mental and physical.

In many cases, indeed, the separation has already been almost effected; the end of the limb hangs only by some strips of skin and muscle which can be divided with a snip of the scissors. And in no case does the removal of the dead parts ever offer any difficulties; the scissors suffice to cut the skin and the remains of the underlying soft parts, and the limb falls.

This is not an operation. As a rule, it is inadvisable to try to do more; do not attempt to trim the muscles or bones or to fashion a regular stump. Be content, after excision of the peripheral segment, with thoroughly disinfecting the gaping wound; with this object, employ free irrigation with very warm boiled water, as already recommended, then bathe the whole area with alcohol, envelop it in compresses soaked in alcohol, and cover it up with a very thick and carefully bandaged dressing.

By this simple method—a method which has nothing brilliant in the very superficial sense in which the word is sometimes used—results will be obtained which are eminently superior to the best which can be given by immediate amputation above the level of injury. One patient, in place of suffering a disarticulation at the shoulder, will recover with a good intra-deltoid stump; another, instead of having his lower extremity amputated through the thigh, will be able to bear his weight on the knee.

I have already said that in certain conditions it becomes necessary to pass beyond these general principles, to transgress them in the letter, to obey them in the spirit. I refer to those cases in which the surgeon is not called until after the lapse of some time: the crushed limb has been allowed to remain uncleansed, and infection already renders itself evident by unmistakable local signs. The period of shock has passed, and it is often best to decide at once to sacrifice the limb by amputation above the seat of injury as the only means of averting threatening complications.

II.—Peripheral Crushes.

The foot and part of the leg, the hand and a portion of the forearm, sometimes an even more extensive segment of the limb, have just been crushed under a heavy vehicle, under the wheels of a waggon, under a fall of earth, etc. The patient is seen almost at once; he is pale, cold, and partially unconscious, the pulse is feeble, the respiration jerky. He is suffering from traumatic shock in its most typical form; the depression of the pulse and the subnormal temperature are the two outstanding features. Once more the question arises, what is to be done with the pulpified limb, hopelessly destroyed, contaminated with dirt and dust, and which a few hours later will form a vast focus of infection? It is a grave and vital question.

Do not amputate; to amputate while shock is at its worst is to invite immediate death. But once the initial symptoms have subsided, when by the aid of injections of salt solution and caffeine, by the envelopment of the limbs and trunk in wool, by inhalations of oxygen, the pulse has improved and the skin become warmer and the contraindications have disappeared, may we—ought we—to amputate? In the great majority of cases, No! **The day of the primary traumatic amputations,** formerly the rule, **is past**; they ought no longer to figure in ordinary practice except under very special conditions. And for several reasons.

Even when the initial shock has passed away, amputations are still dangerous, and the time is evidently very unfavourable for submitting a patient, who has scarcely rallied from one grave injury, to a second traumatism so serious as an amputation through the thigh or a disarticulation at the hip.

This is not, however, in our opinion, the principal objection, and as we shall have cause to say later later on, in the face of certain weightier reasons it may justifiably be set aside.

One would be wrong indeed to exaggerate the gravity of the prognosis of primary amputations, at least when performed under modern conditions; by conducting the anæsthesia very cautiously, by operating quickly and aseptically, the conditions produced are very different from those which formerly obtained and rendered these operations so deadly.

Personally, in twenty high amputations performed during the first few hours I have had only three deaths: one was that of a patient in whom operation was rendered necessary by emphysematous gangrene, and the other two were cases of multiple amputations complicated by serious visceral contusions; and no one of the three patients succumbed until several hours after operation.

There are other weighty arguments against immediate removal of the limb. And firstly, unless amputation is performed very high above the seat of injury, **there is the very real danger of secondary gangrene of the flaps.** That is an occurrence which is actually more common than is generally recognized; it is to be explained by the existence of distant

lesions, vascular lacerations, muscular hæmatomata, etc., in the areas above, sometimes very far above, the region directly affected, and due to the primary traumatism.

On two occasions I have seen a stump become gangrenous *en masse* after primary amputations performed apparently in healthy tissue; after an amputation through the thigh for a crush of the leg, and after an amputation of the leg at the seat of election for injury to the foot. It will therefore be necessary to amputate very high, and consequently *always to sacrifice too much*—that is to my mind one of the gravest defects of the early operation. Of course, the evil varies according to the level at which the amputation is performed, and it is quite possible to sacrifice a longer or shorter segment in the continuity of the leg, the thigh, the forearm, or the arm, without greatly modifying the ultimate usefulness of the stump. It is a very different matter when it is a question of sacrificing the limb *above* or *below* the knee or the elbow, when for instance the immediate operation is represented by an amputation through the thigh, while by the other method the knee might be preserved; or again, in a case where immediate operation would necessitate disarticulation at the shoulder, while by waiting a useful intra-deltoid stump could be obtained.

These are very important arguments in favour of conservative measures.

As a general rule, and excluding the urgent indications which we shall discuss presently, there should be no hesitation in refusing to follow the old teaching; therefore **avoid early amputation, but do all that is necessary to prevent infection.**

This sound surgical precept would, however, lose all its value, and indeed would often be equivalent to a death sentence, if it was considered to mean that the crushed limb was to be practically left to take its chance after a very summary cleansing. The surgeon will only be justified in following this method of "spontaneous and conservative elimination" if he is prepared to devote himself at once to a process of minute cleansing and disinfection. This is the manner in which he will proceed. The skin of the limb is shaved, brushed with warm, soapy water, rubbed with ether and alcohol. Then attention is directed to the deep area of injury. The fragments of bone, bare of periosteum, the tags of muscle, and the loose tendons are removed; then with an irrigator placed at a sufficient height to give good pressure, and filled with boiled water at a temperature of 140° F., a powerful jet of fluid is directed systematically over the entire surface and into all the recesses of the wound, into the smallest corners, between all planes of separation; all clots and foreign bodies are washed away, and the irrigation is not discontinued until the whole of the injured area has been thoroughly and slowly gone over (Reclus[1]).

Then, with swabs soaked with pure peroxide of hydrogen (12 volumes), all the recesses are cleansed anew; gauze wet with peroxide of hydrogen

[1] P. Reclus, "De la conservation systématique dans les traumatismes des membres," *Revue de chir.*, 1896, p. 1.

or alcohol is packed into all the planes of separation, around the flaps, into all interstices ; the limb is completely enveloped with more layers of gauze also saturated with peroxide or alcohol, and finally a thick covering of sterilized wool is applied and carefully fixed and closed above and below by a bandage. If there is no rise of temperature, this first dressing is left untouched for eight or ten days.

It may be that the crushed extremity remains attached only by some slender tags of muscle and skin ; it will then be advantageous to get rid of it by a few cuts of the scissors. Often, indeed, it will be good practice to limit the area of gangrene by excising the peripheral segment through the dead tissues ; the field of gangrene is thereby rendered less extensive, and its disinfection becomes much easier.

Case 30.—We followed this line of treatment, with an unexpectedly good result, in the case of a man, 44 years of age, whose hand and forearm up to about two inches below the elbow had been reduced to a pulp ; the skin was stripped and split to above the joint, and as the bleeding had been very profuse, a tourniquet had been applied and had remained in position for several hours. The general condition was fairly satisfactory and the temperature was 98·6.° The patient was anæsthetized with ether, and we began by carefully washing the whole region with soapy water, sublimate solution, alcohol, and ether. The lower half of the forearm, which was simply a pulp and already gave off a fœtid odour, was first of all excised with the scissors and a few strokes of the chisel ; the arteries were tied, the radius and ulna divided a couple of inches below the joint, and the skin and muscles trimmed without any attempt to form a flap. Several pints of very warm boiled water, as hot as the hand could bear, were then used to cleanse the whole surface of the muscles, the deep surface of the skin, and the recesses of the vast irregular wound, and the irrigation was continued until every clot and all débris had been washed away and the tissues appeared to be perfectly clean. The cleansing was repeated with alcohol ; then strips of gauze soaked in alcohol were packed in between the different layers, and large pieces of gauze also saturated with alcohol were applied over all ; lastly a thick layer of wool completed the dressing. At the end of twenty-five days, when the dressing was removed, the whole wound was found to be covered with a healthy granulating layer, the tissue planes had become adherent, and the recesses were to a great extent obliterated. Complete healing took a long time : it required four months, but in the end the patient left hospital with a good forearm stump, rather short but very useful.

After the long-continued, minute, and complete cleansing of the crushed segment with warm boiled water, embalming it in alcohol is an excellent practice which we have often employed with success. I need hardly say that the case must be very closely watched, and that any undue pain, any rise of temperature, any stain coming through the dressing, will indicate the necessity for at once investigating the condition of the wound.

After these injuries, and in every case of a wound contaminated with street dirt, dust, etc., it is prudent to administer prophylactic injections of antitetanic serum. Ten cubic centimetres are injected under the skin as soon as possible ; the injection is repeated after forty-eight hours, and a third time towards the tenth day.[1]

[1] Nocard, Reclus, Bazy. (See Landouzy, *Les Sérothérapies*, p. 51).

Such ought, as a general rule, to be the line of treatment of crushing injuries of the limbs. There still remain, however, **some indications for early amputation.**

1. The injury is of some hours' standing; **the wound is impregnated with earth, and dirt of all kinds,** and has received no attention. The injury affects the foot or the hand, and the damage is such that there can be no doubt that the distal portion of the limb is lost beyond hope of recovery; in such circumstances the method of spontaneous elimination—supposing that it was followed by success—would be attended by no other advantage than the preservation of a somewhat longer segment of the leg or forearm.

The possible gain is too small, when one takes into consideration the dangers of infection which are incurred in such a case, and the difficulties, the practical impossibility, of adequately disinfecting the wound. It is usually best to amputate at once at the seat of election.

2. The problem presents itself in analogous terms, but even more definitely, when **infection is already established** and has assumed alarming characters.

Under such circumstances, it is too late to think of trying to save a more or less extensive portion of the damaged limb; *it is the patient's life which is to be saved*, and early and radical amputation is often the best line of action. It may even sometimes be the best means of avoiding more extensive sacrifice of tissue.

Case 31.—Elsewhere I have reported the case of an unfortunate workman who had absolutely refused to allow his foot to be amputated, and in the end the limb had to be disarticulated at the thigh. His left foot had been crushed under the wheel of a travelling crane weighing approximately sixty tons; the accident had occurred several days before the man was admitted into La Pitié. His foot was in a terrible state, covered with sloughs and infiltrated with pus; the temperature was 103°, and he looked ill. Amputation of the leg was urgently necessary, but our patient would listen to no reasoning, and we were compelled to restrict ourselves to making free incisions. In spite of all, infection slowly advanced; at the end of two months, exhausted, almost dying, the patient consented to a disarticulation at the knee, opposing with strange obstinacy the suggested amputation through the thigh. The situation did not improve, and finally, *in extremis*, he consented to allow us to do what we could. Amputation of the thigh, even subtrochanteric, had become impossible. I disarticulated at the hip, and against all hope my patient recovered. That was eleven years ago; he is well and strong, and works for his living; but instead of bearing his weight on his pelvis, he might have had a good leg stump.

The matter may be summed up as follows:—

1. **In recent crushes**—even when there is but little shock, or when its initial phase is past—**the set amputation above the seat of injury ought to be abandoned**; and for it, **minute disinfection of the focus of injury and embalming of the limb ought to be substituted,** after the peripheral portion of the crushed limb has been removed.

2. **In infected crushes amputation is usually necessary** as a life-saving procedure, and must be resorted to in good time.

URGENT AMPUTATIONS.

Fingers.—In cases of crushing injuries of the fingers, it is conservation of *function* which must be kept in view; the preservation of a long stump of finger will serve no good purpose if it is stiff, ankylosed, deformed, useless, and in the way. As a rule, in treating the crushes involving one or more fingers, the method just described ought to be employed. Excise nothing beyond the almost completely separated fragments, cleanse the whole area thoroughly with very warm sterile salt solution and alcohol, dress with aseptic gauze and wool, change the dressing as seldom as possible, and wait until the natural processes have

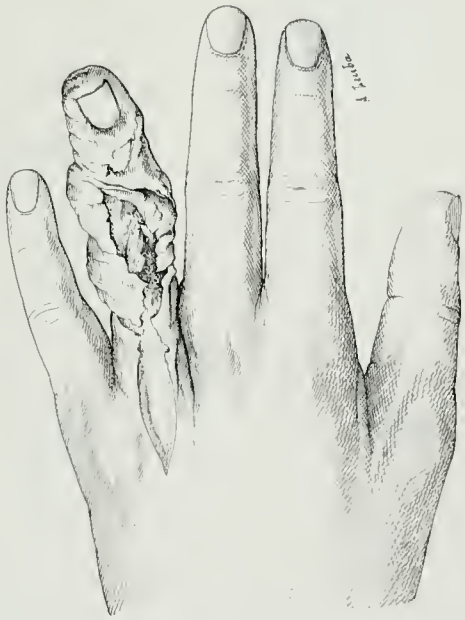


Fig. 433.—Complete crush of the ring finger. 1st step in the disarticulation: dorsal incision.

marked out the limits of the dead tissues, before resorting to any reparative operations.

By acting thus, unexpectedly good results will often be obtained, and here again immediate excision always courts the risk of being too extensive; still there are certain types of digital crushes, in which the primary lesions, the laceration and separation of the skin, the comminution of all the phalanges, the exposure and dislocation of the joints, the tearing of the vessels and nerves, permit no expectation of any good results—functionally at least—from conservative measures. In other cases, the injury is quite recent, the lesions definite and limited; it is, in short, a comminuted fracture of one or several phalanges, with a contused wound.

Is it necessary or desirable in either of these eventualities always to refrain from any primary operation? Certainly not, if the conditions are such as to permit the necessary operation being performed in a satisfactory manner.

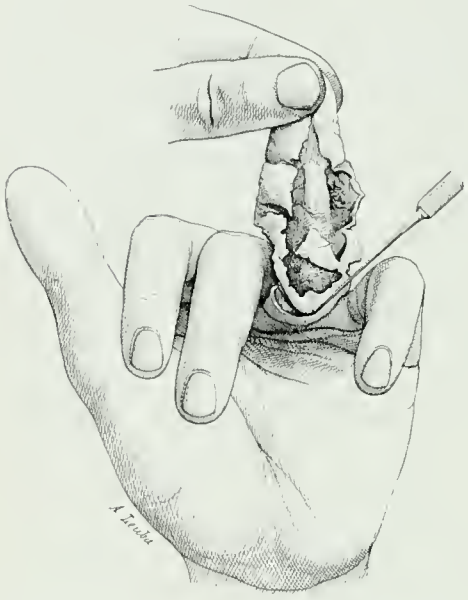


Fig. 434.—Complete crush of the ring finger. 2nd step in the disarticulation: the anterior circular incision.

An Esmarch's bandage is applied around the forearm; the hand and fingers are carefully cleansed, the wound being kept covered and protected by a fold of sterile gauze. Attention is then directed to the injury itself; it is opened up and examined in the manner already described; detached splinters of bone, dirty and discoloured tags of fibrous tissue and fat are excised; bone fragments and torn tendons are brought together, the skin is arranged as well as possible, the torn strips being spread out, cleansed, the margins brought into contact, perhaps even sutured here and there; the suturing will, however, always be incomplete. Then the finger will be immobilized in a good dressing, reinforced if necessary with a palmar splint. In this manner the processes of natural repair will be simplified and hastened.

If the end of the finger or the entire finger is completely crushed, or if the skin or the tendons are so extensively lacerated and destroyed that any real functional restoration is out of the question, nothing is to be gained by waiting; and immediate excision, by preventing the septic complications which are always to be feared, and the joint stiffness which follows long-continued immobilization of the hand, will often be the best line of treatment, under the reservation of course

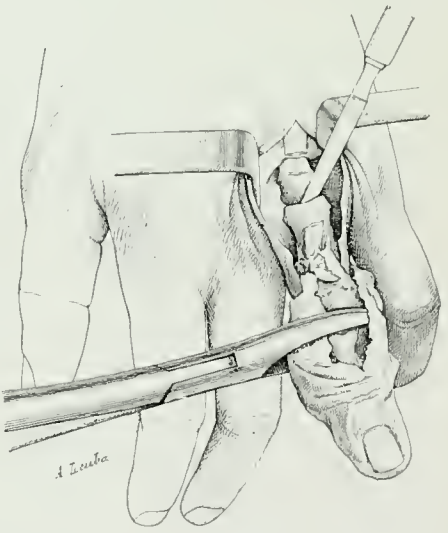


Fig. 435.—Complete crush of the ring finger. 3rd step in the disarticulation.

that it is only adopted when the lesions are quite evidently irremediable. At a somewhat later date, complicating inflammatory symptoms may render amputation urgently necessary.

Further, the treatment must be governed by certain special considerations, and is also modified a little according to the finger which is affected; one of the two *intermediate fingers*, *the index*, *the little finger*, or *the thumb*.

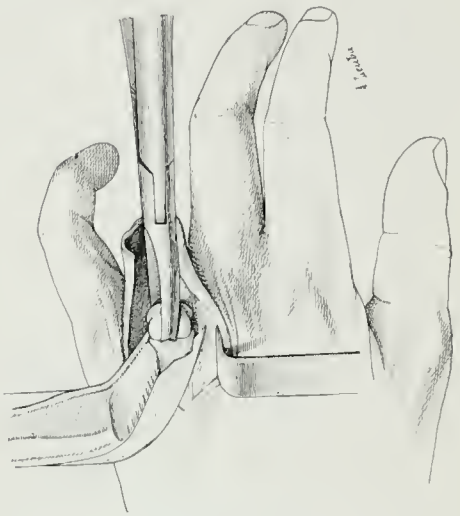


Fig. 436.—Complete crush of the ring finger: 4th step in the disarticulation: excision of the head of the metacarpal bone.

When an **intermediate finger**, the medius or the ring finger, is crushed close to the metacarpo-phalangeal articulation, it is useless to attempt to save a stump of the first phalanx; the little bony process has usually very slight mobility, is quite useless, and interferes with the action of the other fingers by preventing their approximation. For the same reason, it will be well, after disarticulating, to resect the head of the metacarpal bone. The operation will be conducted as follows:—

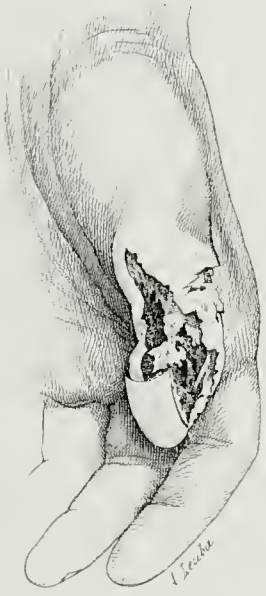


Fig. 437.—Complete crush of the thumb.

Make a dorsal incision (*Fig.* 433) which extends a good half inch above the head of the metacarpal; raising the finger, incise it circularly from left to right in healthy skin, at the border of the crushed area, and carry the incision on either side to join the dorsal cut (*Fig.* 434), quickly dissect round the articulation, taking care to keep close to the bone and to avoid damaging the two cutaneous flaps; disarticulate (*Fig.* 435). Then grasp the head of the metacarpal with lion forceps, free it up to the neck, and at that level divide it with bone-cutting forceps (*Fig.* 436).

In the case of the **index** or **little fingers**, amputation in the continuity of the first phalanx, even quite close to the metacarpal, may be good, if there is plenty of skin to cover the bone comfortably, and the phalangeal stump remains mobile; if the finger is disarticulated, the head of the metacarpal should be preserved, and care taken that it is well covered on the outer side.

With the thumb, an attempt must be made to retain the longest possible segment of phalanx, and consequently primary excision is very seldom indicated. If it is necessary to sacrifice a thumb that has been crushed to a pulp (*Fig.* 437), or is suppurating or gangrenous, the soft parts will first be dissected up, the incision following the exact margin of the still living skin, no matter how irregular its outline may be ; the multiple tags of skin will be raised without any attempts to fashion regular flaps. The end of the first phalanx being held with forceps, the soft parts and the

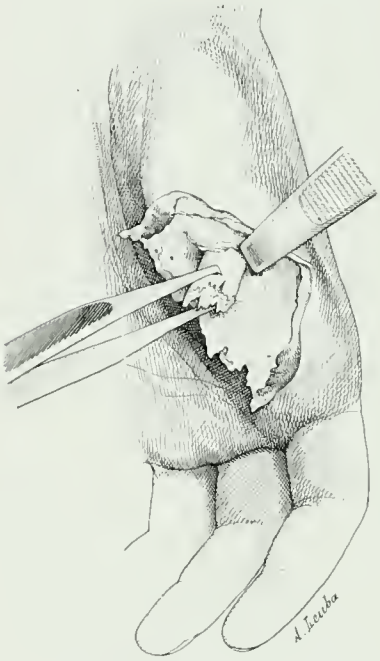


Fig. 438.—Complete crush of the thumb : raising the uninjured soft parts, denudation of the end of the first phalanx.

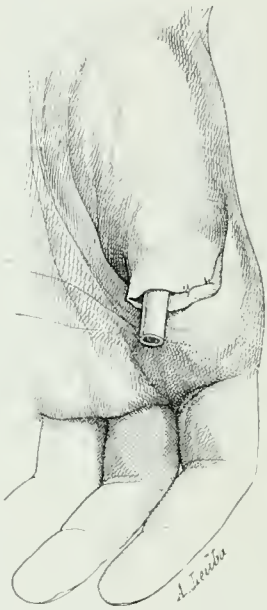


Fig. 439.—Complete crush of the thumb : the amputation terminated; the proximal end of the first phalanx preserved.

periosteum will be carefully separated with an elevator (*Fig.* 438) and then with the bone-cutting forceps or the gouge-forceps just as much of the phalanx will be excised as will allow the rest to be properly covered in by what skin is available. It then only remains to bring the skin and other soft tissues together, trimming them a little if possible, and leaving the wound partially open (*Fig.* 439).

The Hand and Forearm. The same governing principle must be observed in amputations of the hand and those of the lower part of the forearm ; the classical methods must only be employed when they permit the maximum of economy. In the forearm a circular amputation should always be preferred if it is practicable ; if, however, the tissues

are so much infiltrated that they cannot be turned back in a circular cuff, or if the operation must be performed at a somewhat higher level, very good results will be obtained with amputation by anterior and posterior flaps cut by transfixion (*Fig.* 440). When the lesions extend above the wrist on one side of the forearm only, it will be well, instead of amputating above the upper limit, that is to say, very high—too high,—to fashion a lateral flap (*Fig.* 441), which must be dissected up carefully from before backwards (*Fig.* 442). In these atypical operations the covering of soft parts of the bone may be obtained from wherever possible, provided it is ample.

The Arm. In the arm a circular amputation is always indicated. Sometimes, when the limb is greatly swollen, it will be found advantageous first to make a circular incision, and to complete it by two vertical cuts (*Fig.* 443); the muscles will be treated in the same manner, two flaps being raised.

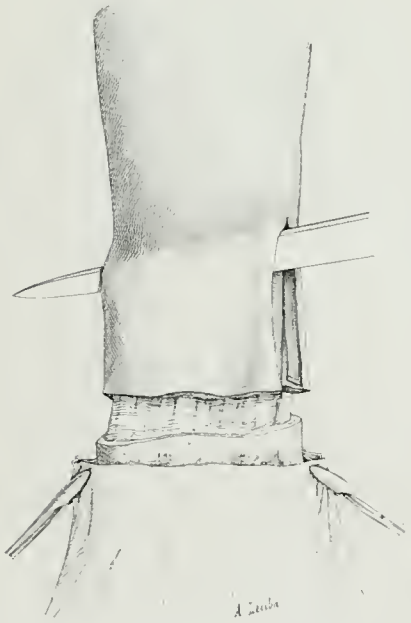


Fig. 440.—Amputation of the forearm by two flaps

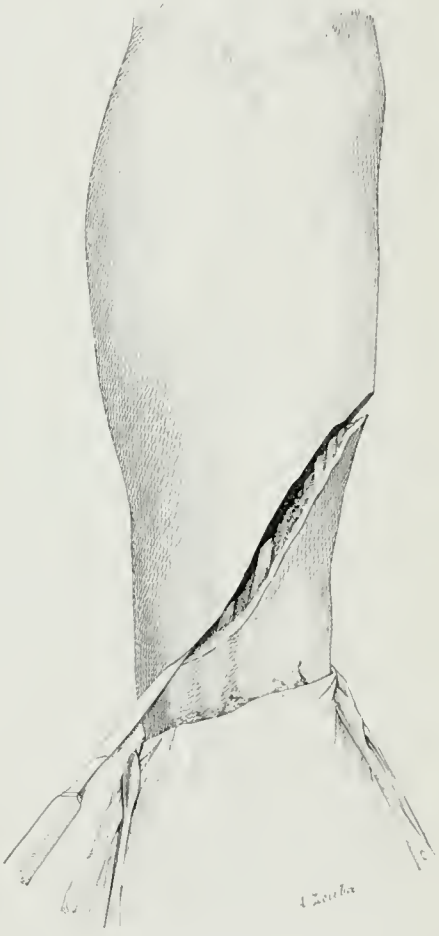


Fig 441.—Amputation of the forearm by a single lateral flap.

High up in the arm, an intradeltoid amputation is always better than a disarticulation; care will be taken to strip the humerus completely, and by so doing it will be possible to get right up to the joint (*Fig.* 444).

In dealing with **the lower extremity**, conservative measures are again indicated, but when operation is necessary, it must not be forgotten that the conditions are different.

The Toes.—With the toes it is unnecessary so persistently to endeavour to save a small segment as with the fingers, but in cases of disarticulation it is always well to preserve the head of the corresponding metatarsal bone to serve as a point of support. If possible, it is often better to amputate through the first phalanx than to disarticulate at the metatarso-phalangeal joint.

Fig. 442.—Amputation of the forearm by a lateral flap. Raising the flap; the broken ulna is steadied by the lion forceps.

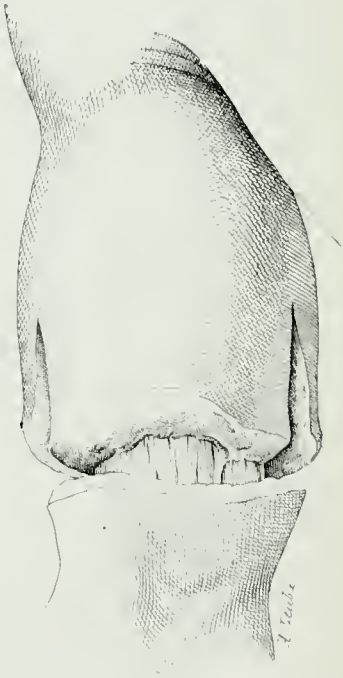


Fig. 443.—Circular amputation of the arm, with two lateral incisions.

In **the great toe**, the base of the first phalanx and the sesamoid bones should be preserved, as they provide a better base of support than the head of the metatarsal alone. A small dorsal flap and a large plantar flap are marked out and dissected up to the point at which the bone is to be divided, the tendons are cut and allowed to retract, and, the toe being steadied with lion forceps, the phalanx is sawn transversely (*Fig.* 445).

With the other toes also, it is better to amputate through the first

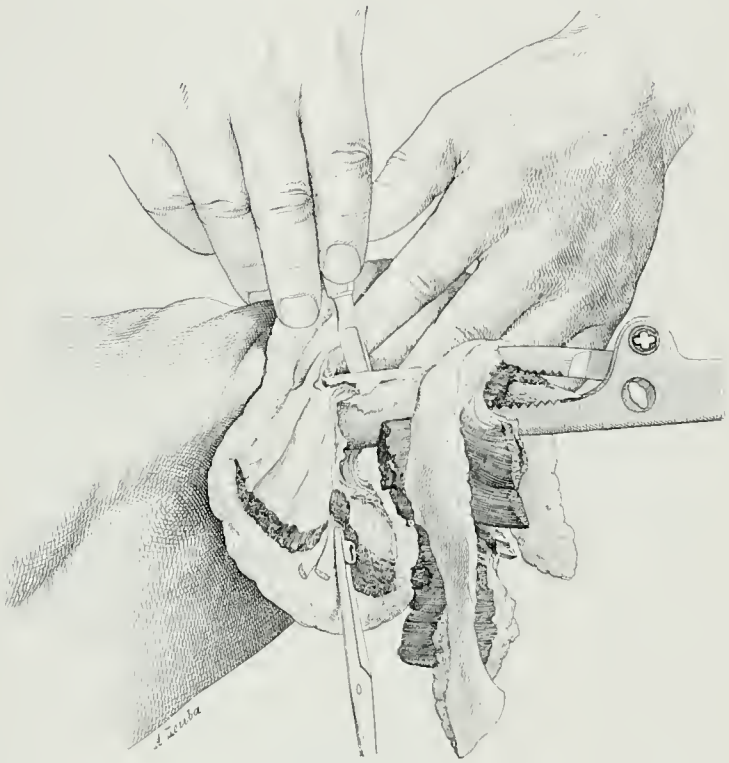


Fig. 444.—Intradeltoid amputation of the arm.

phalanx than to disarticulate at the first interphalangeal joint; a circular

Fig. 445.—Amputation of the great toe, through the first phalanx.

Fig. 446.—Amputation of a toe through the first phalanx.

incision with a dorsal extension will be made, and the bone divided with cutting forceps (*Fig.* 446).

I need only mention the internal dorsal flap used in complete disarticulation of the great toe, and the external dorsal flap for the 5th toe (Farabeuf) ; in either case the object is to avoid a scar on the lateral border of the foot where it would be exposed to the friction of the boot.

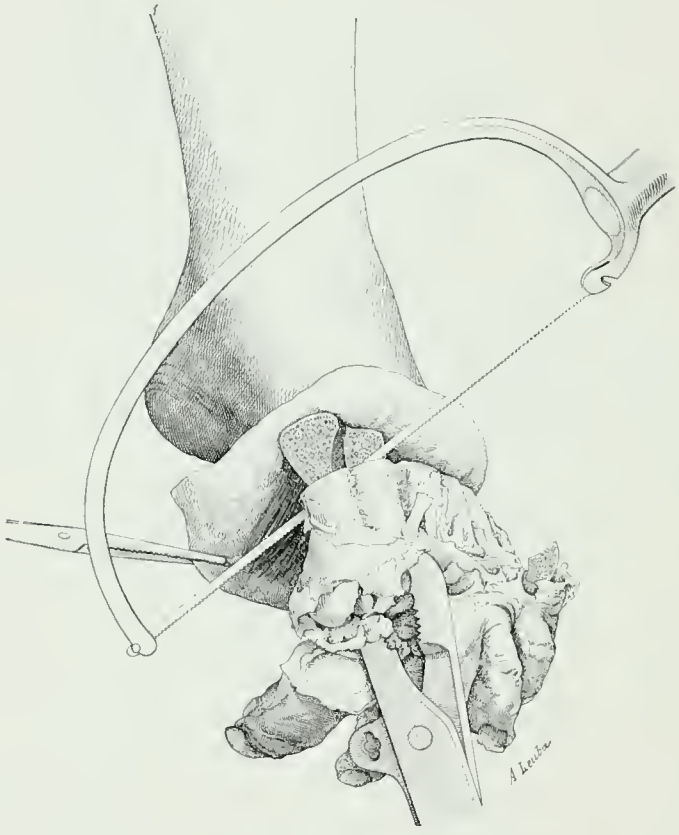


Fig. 447.—Amputation of all five metatarsals.

The Foot.—The amputation of **several metartarsals,** particularly of the external metatarsals, is an operation which generally gives very good functional results, and the mutilated foot accommodates itself wonderfully to the altered conditions. One of my patients, in whom I amputated the 3rd, 4th, and 5th metatarsals six years ago, has since won prizes as a runner.

In some injuries of the toes and the forepart of the foot, **simultaneous amputation of the five metatarsals** is an excellent operation, one that is easier and less serious than a " Lisfranc," because the tarsal joints are not opened. A sufficient extent of uninjured sole is necessary ; a good

large plantar flap is cut, and a dorsal flap about 1½ inches in length is raised

Fig. 448.—Pre-scaphoid disarticulation, with section of the cuboid.

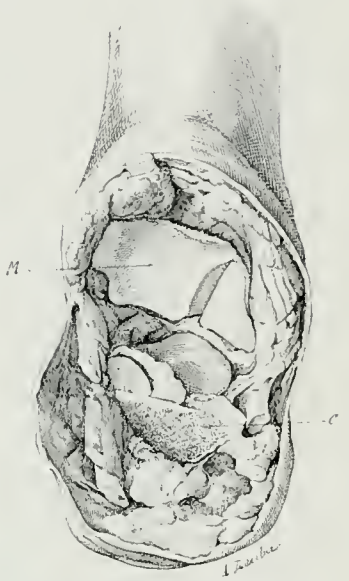


Fig. 449.—Inter-tibio-calcaneal amputation (Ricard). (M) The socket of the ankle joint, in which the os calcis will be received. (C) The os calcis, the anterior portion of which has been excised.

in a cuff, and the bones are sawn from within outwards and from before backwards (*Fig.* 447).

Fig. 450.—Tibio-tarsal disarticulation: Syme's method. 1st step: the plantar incision.

In **the tarsus** one must try to save as much as possible of the bone, according to the amount of soft parts available for the formation of flaps ;

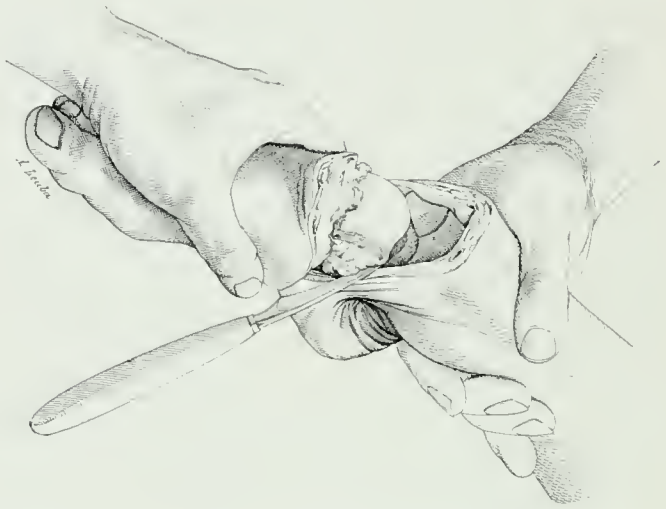


Fig. 451.—Tibio-tarsal disarticulation : Syme's method 2nd step : disarticulation ; denudation of the lateral surfaces of the os calcis.

it is therefore inadvisable to strive to perform one of the classical operations.

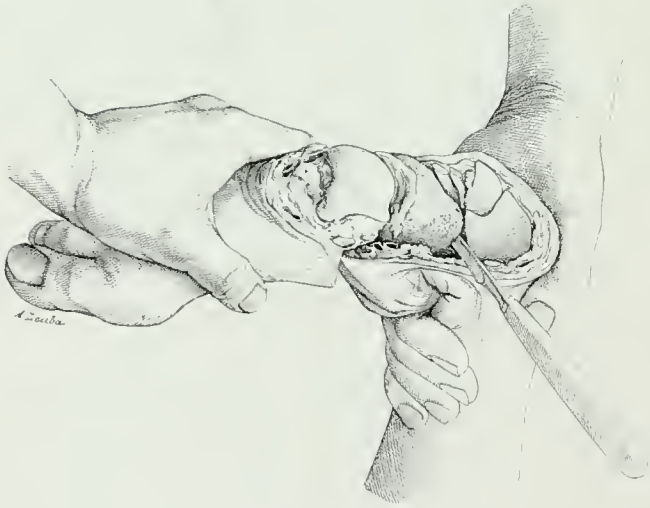


Fig. 452.—Tibio-tarsal disarticulation. Syme's method. 3rd step. Freeing the postero-inferior surface of the os calcis.

A "**Chopart**" gives very good results if healing is obtained by first intention, and if the anterior tendons adhere to the plantar flap. The

"**subastragaloid**" **disarticulation** is too difficult an operation to be considered in the urgent conditions we have in view, and the same may be said of the various osteoplastic methods.

But some other "atypical" procedures ought to be known. For instance, **the pre-scaphoid disarticulation with section of the cuboid** (*Fig.* 448) is sometimes an excellent operation; and again, in place of removing the whole foot, one may in some cases follow Ricard's example, and after having disarticulated at the mediotarsal joint (Chopart's operation), extirpate the astragalus, and if necessary the anterior part of the os calcis (*Fig.* 449); shortened in this way, or preserved entire, the os calcis is received in the ankle joint socket, and a very good heel stump is obtained.[1]

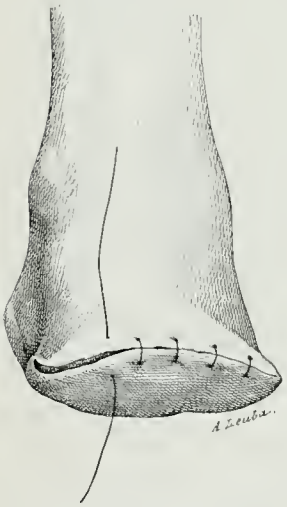


Fig. 453. Tibio-tarsal disarticulation, Syme's method. Suturing the flaps.

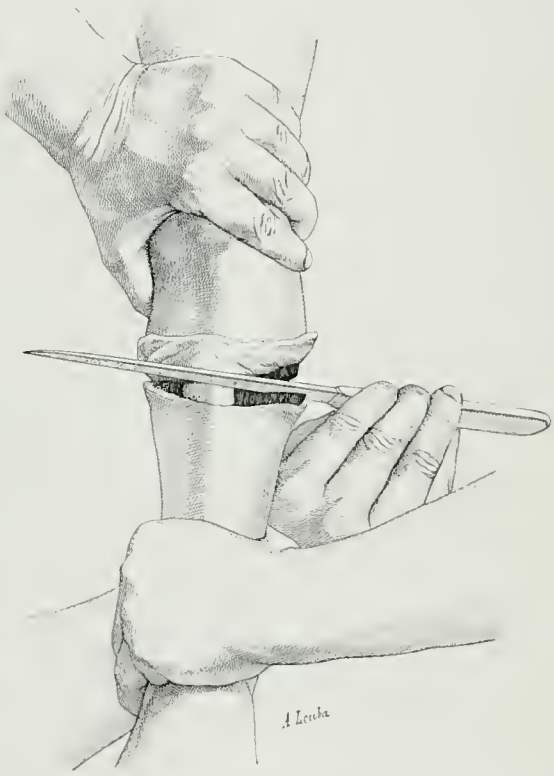


Fig. 454.— Circular amputation of the leg at the seat of election. The anterior part of the cuff is raised; line of the circular section of deeper tissues.

When it is necessary to sacrifice the whole foot, we recommend **Syme's operation**; it has on many occasions given us most satisfactory results. There is only one slight difficulty associated with it, and that is in the enucleation of the os calcis. Shortly, it is performed as follows: Have the

[1] *See* CHOCHON-LATOUCHE, *L'amputation de Ricard ou amputation inter-tibio-calcanéenne.* Thèse de doct., Paris, 1908.

foot raised, and begin the transverse plantar incision just below and in the axis of the external malleolus, and carry it below the heel, to terminate a finger's breadth below the internal malleolus ; cut right down to the bone at once, and with a few touches with the point of the knife free the margin of the heel flap and definitely expose the os calcis (*Fig.* 450).

Turn down the foot, and join the two extremities of the plantar incision by a second cut over the front of the ankle-joint ; divide the tendons, and

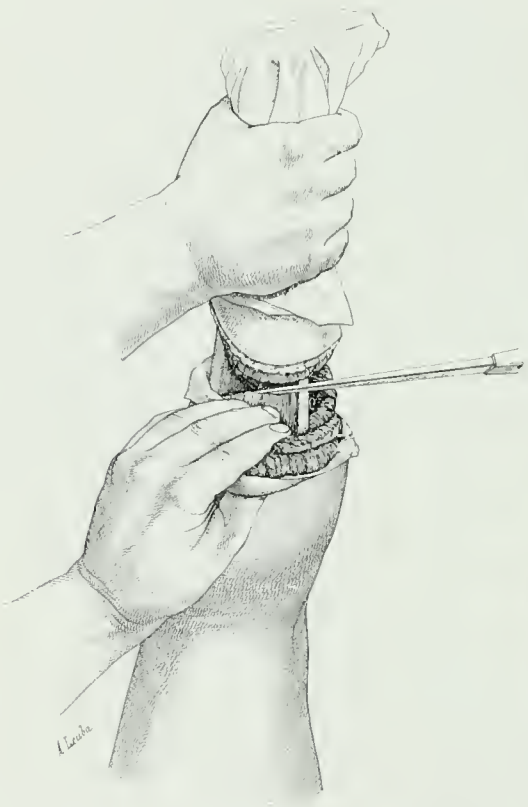


Fig. 455.—Circular amputation of the leg at the seat of election. Section of the deep muscles of the calf.

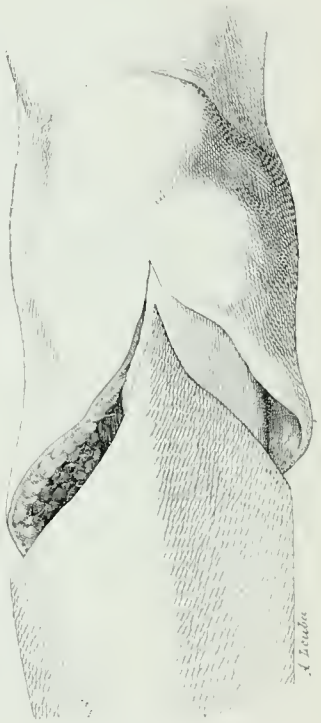


Fig. 456.—Intra-condyloid amputation of the leg. Anterior racquet incision.

open the joint by cutting on the prominence of the astragalus. Divide the lateral ligaments from above downwards, and then, drawing the foot forwards, and twisting it from side to side, free the os calcis (*Fig.* 451).

There only remains the attachment of the tendo Achillis ; expose it by bending the foot forcibly backwards, and by careful transverse cuts of the knife detach it from above downwards (*Fig.* 452). Then expose the malleoli, and saw them off, together with a thin layer of the lower end of the tibia, and terminate the operation by suturing the two flaps together (*Fig.* 453).

The Leg and Thigh.—In the leg and thigh, the circular amputation ought always to be the method of choice, but here again a flap operation or some atypical procedure may be indicated by the nature of the lesions.

In cases of injury of the leg, the lowest possible amputation is only indicated when the patient will ultimately be able to furnish himself with a satisfactory artificial limb, and when his occupation does not entail any heavy work. In the opposite conditions, when practically the knee alone can be used to transmit the weight of the body, a long leg stump is an actual disadvantage, and it is advisable to go at once to the seat of election (a hand's-breadth below the knee-joint).

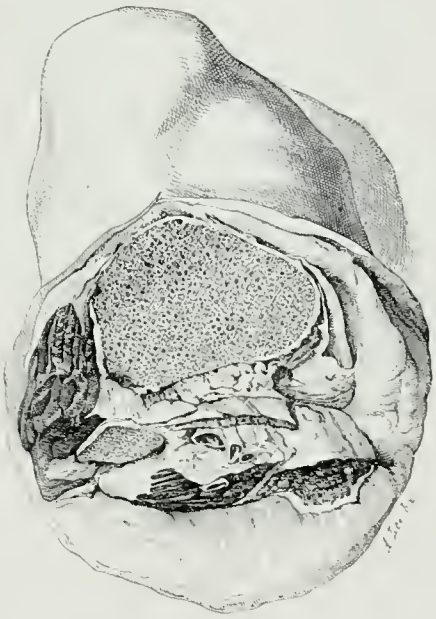


Fig. 457.—Intra-condyloid amputation of the leg.

In performing the circular operation, care must always be exercised to raise a good cuff, two inches broad at least, in front (*Fig.* 454); and after having made a first circular sweep of the knife through the superficial layer of muscles, to have the foot raised in order to complete the division of the deep muscles; and lastly, carefully to separate the soft parts from the bones (*Fig.* 455). This step is of capital importance, and ought to be executed deliberately; it is only by this graduated division of the muscles and high clearing of the bones that one is enabled to apply the saw in a good position and to obtain an adequate cone of the soft tissues.

It will sometimes be necessary to amputate the leg at a higher level still, **through the condyles**; in these cases, and when the nature of the lesions does not necessitate an amputation through the thigh, serious

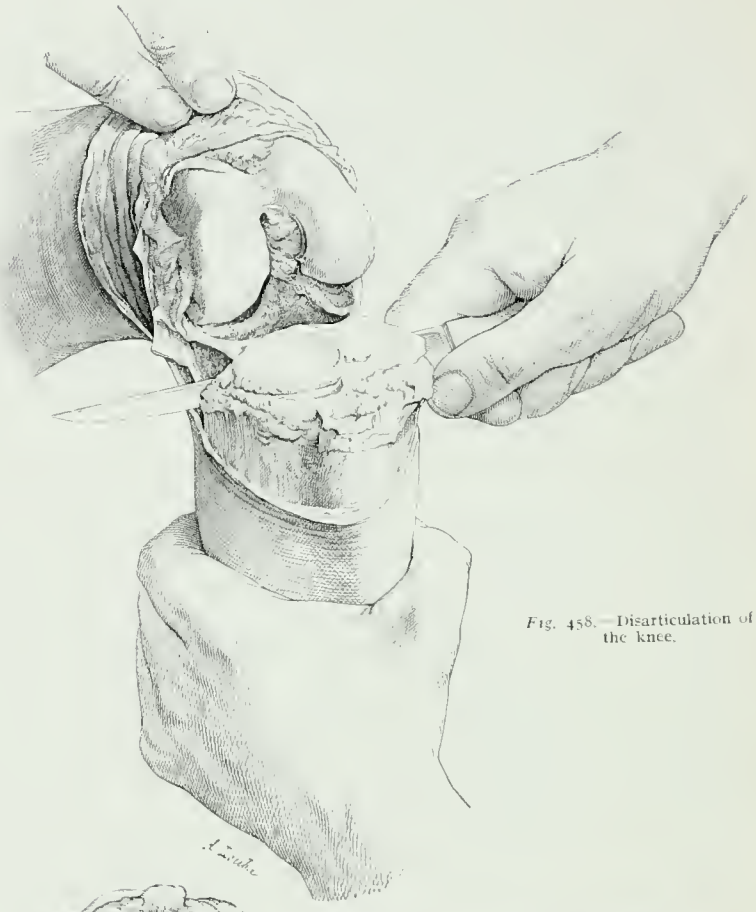


Fig. 458.—Disarticulation of the knee.

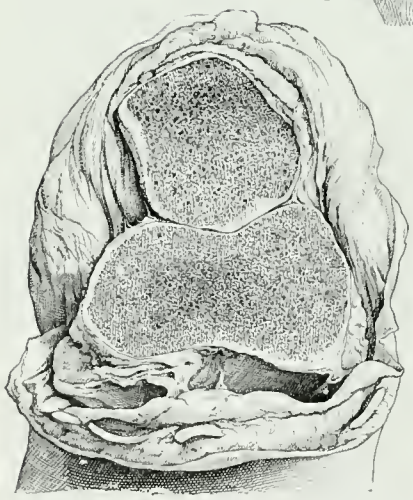


Fig. 459.—Gritti's amputation. The flap has been cut and raised; the patella and femoral condyles have been sawn.

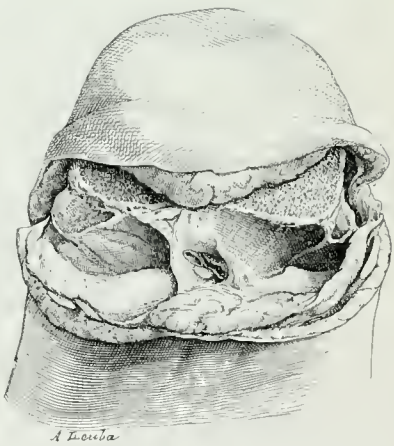


Fig. 460. — Gritti's amputation. The flap turned down and the patella adjusted to the cut surface of the femur.

consideration must be given to the ultimate functional condition, and only those methods which best assure a useful stump should be employed. The weight of the body is very much better borne by the knee after a high amputation of the leg, than by a thigh stump; and on the other hand, the longer a thigh stump, the more useful it is. A more important place

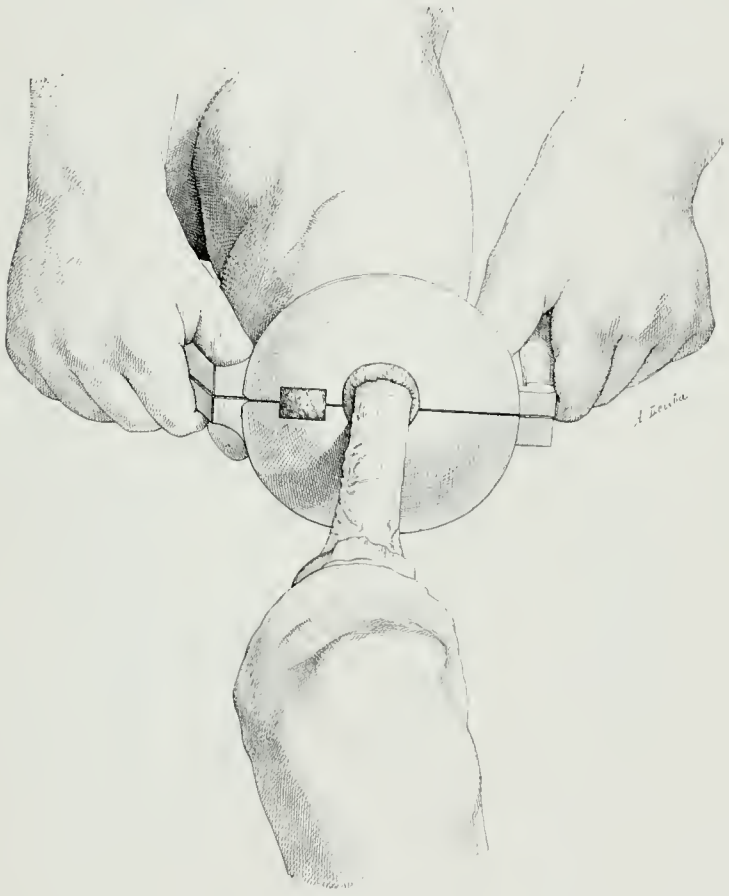


Fig. 461.—Circular amputation of the thigh: using the shield retractor [1]

than is usually given to them ought therefore to be reserved for the intracondyloid amputations of the leg, disarticulation of the knee, and the intracondyloid amputation of the thigh by Gritti's method.

Figs. 456 and 457 show a method which can be recommended in cases where a **very high amputation of the leg** is necessary; an anterior,

[1] The retractor depicted is Percy's as modified by M. Dujardin-Beaumetz, and is used regularly by us.

racquet-shaped incision is employed (*Fig.* 456); the posterior flap is cut by dissection with the leg raised, and when turned forward ought to cover the face of the stump without traction; the sharp anterior margin of the tibia must be carefully rounded off. I have employed this method on two occasions with very good ultimate results. The bone section may be made as high up as the insertion of the patellar ligament if there is a sufficiency of soft tissues to form a satisfactory flap, and if the stump is immobilized immediately at a right angle to the thigh.

Fig. 462.—Subtrochanteric amputation of the thigh. External racquet incision: the femoral vessels have been caught with forceps and divided.

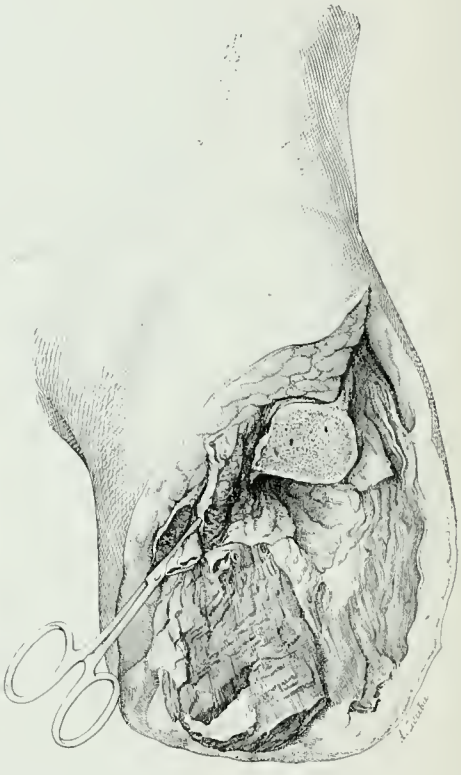


Fig. 463.—Subtrochanteric amputation of the thigh. The flap; the bone section.

Disarticulation of the knee is performed with two flaps: a large anterior one, extending one diameter below the line of the knee-joint, and a short posterior flap; the latter is cut from before backwards after disarticulation, as shown in *Fig.* 458.

In **Gritti's amputation** also, a large anterior flap, including the patella and the insertion of the quadriceps, is marked out and dissected up; the flap is turned upside down to expose the articular surface of the patella, which is then sawn off, the bone being held steady with lion forceps; the

femur is sawn about two inches above the lower end (*Fig.* 459). The patella is then turned down (*Fig.* 460) and fixed flat in good position to the under surface of the femur by two sutures.

Higher up, **in the lower third and in the middle part of the thigh,** the circular method is best. Thanks to the use of the retractor shown in *Fig* 461, the performance of the operation becomes remarkably simple, even in the upper part of the limb; after circular section of the skin and the muscles, the soft parts can be very easily retracted as far as is convenient for the division of the bone in a good position.

At the hip, a subtrochanteric amputation is always to be preferred to a disarticulation; a racquet-shaped incision with the straight part to the outer side is made; in front the vessels are exposed at once and tied (*Fig.* 462) directly the soft parts have been cut, the femur is easily enucleated and sawn as high as is necessary (*Fig.* 463).

WOUNDS OF THE SOFT TISSUES.

We must distinguish between (1) *Incised wounds*, (2) *Contused wounds* (including gunshot wounds), and (3) *Extensive crushes of the soft tissues.*

1. **Incised Wounds.**—Every recent clean-cut wound ought to be **cleansed, dried, and sutured.**

In my opinion infection of wounds is due, not so much to the instrument producing the wound, as to the manipulations to which they are almost always subjected, and to the more or less avoidable contact with septic materials (see later, under BURNS).

Refrain from inundating the raw surfaces with antiseptic fluids; mechanical cleansing with warm boiled water is the surest and most scientific method. With hands *properly prepared*, wash, not only the edges of the wound, but the whole area widely around, with soap and water, alcohol, and ether; open up the wound and irrigate it thoroughly with warm boiled water, with a sterile swab wipe the surfaces lightly, and remove the clots and any foreign particles, until the whole field is perfectly clean. Then with another swab dry the wound carefully and suture it.

We have already discussed the methods of suturing the skin (see Vol. I., p. 17). Let us add that this suturing can quite well be done with any needles, providing they have good sharp points and are properly handled. In addition to Reverdin's needle, we may mention the slot-eyed needles of Collin and Moij (*Figs.* 464, 466), Félizet's very simple and easily sterilizable needle; lastly, the ordinary suture needles; and if nothing else is available, a good ordinary sewing needle is perfectly serviceable.

In certain regions, in the face for instance, it is sometimes advisable, for the sake of obtaining a fine and scarcely visible scar, to employ **the intradermic suture**; Reverdin's intestinal needle or the small needle shown in *Figs.* 467, 468 is used with fine catgut (0 or 00). The thread is

passed through the skin from without inwards, a little above the upper angle of the wound, and when a sufficient length has been drawn through, its further progress is arrested by a knot; it then describes a series of alternating loops, first in one edge then in the other, keeping in the dermic layer (*Fig.* 467), until the lower angle is reached, where it again passes through the skin, this time from within outwards (*Fig.* 468); sufficient traction is applied to bring the skin edges exactly together, and the suture is secured by a second external knot.

Fig. 464. Needle with slot eye (Collin).

In place of sutures, **Michel's metallic clips** may be used. The edges of the skin being carefully adjusted with a dissecting forceps, a clip is seized between the slightly excavated jaws of another special forceps and applied transversely across the line of union (*Fig.* 469), and then, by pressing the two limbs of the forceps together, the clip is bent and fixed in place. The closure of the wound can in this way be effected very quickly. Care must be taken not to press the clips too forcibly together, otherwise they will cause pressure necrosis; exact adjustment of the skin is all that is necessary. The clip-holding forceps which we have just mentioned is the only special instrument required; it is convenient, however, to have a carrier for the

Fig. 465.—Felizet's needle.

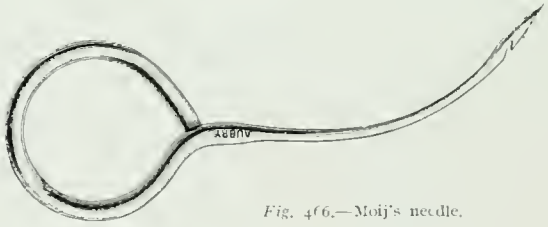


Fig. 466.—Moij's needle.

clips similar to that which is shown in *Fig.* 469, which can be fixed on to the forceps which is used to approximate the edges of the wound; Michel's clip-hook simplifies the work considerably, but is in no wise essential.

The clips are removed on the eighth day; a small hook is introduced into each of the pair of small eyelets, one on either side of the clip, and by pulling gently on them, first to one side then to the other, the points are disengaged and the clip can be removed. Or again, two slender pressure-forceps may be slipped, one under each lateral, bent-in portion

of the clip, which is then, by slight simultaneous rotation of the forceps, straightened out and disengaged from the skin. With the forceps represented in *Fig.* 470, this little manœuvre can be executed very simply.

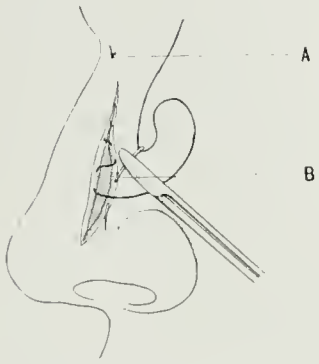


Fig. 467.—Intradermic suture. (A) Initial knot arresting the thread at its point of departure. (B) The intradermic loops.

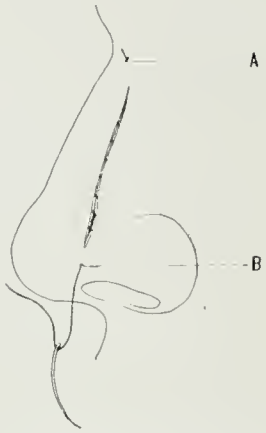


Fig. 468.—Intradermic suture. (A) The initial knot. (B) The thread traversing the skin from within outwards at the lower angle of the wound.

If the wound is *deep*, suturing of the skin alone is not sufficient; it is necessary—and it is one of the conditions essential for primary healing—that all the successive layers, all the divided tissues, should be brought together, and that the two sides of the wound from the surface to the bottom, should be in intimate contact. The reunion of the deeper tissues will be effected as follows:—

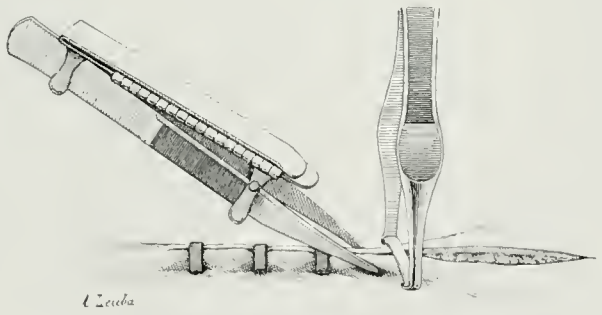


Fig. 469.—Closing a wound with Michel's clips

(*a*). Take for example, a cut passing deeply into the muscles, a knife stab in the back, in the hip, into the fat of the thigh, the calf, or the arm; the wound is very long and its edges are somewhat everted.

Pass a series of deep sutures, each of which enters at three-quarters of an inch or an inch from the margin of the wound and passes through the

whole thickness of the divided tissues, right to the bottom of the wound; then changing its direction it follows a similar course on the opposite side,

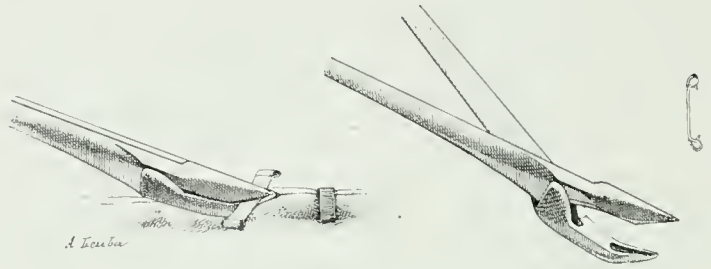


Fig. 470.—Method of removing Michel's clips. (On the right the forceps used in removing the clips and a clip in lateral view are shown.)

to emerge at a point symmetrical with that of its entrance. Tie the sutures slowly and steadily, while an assistant, with his two hands, applied flat, presses the lips of the wound together.

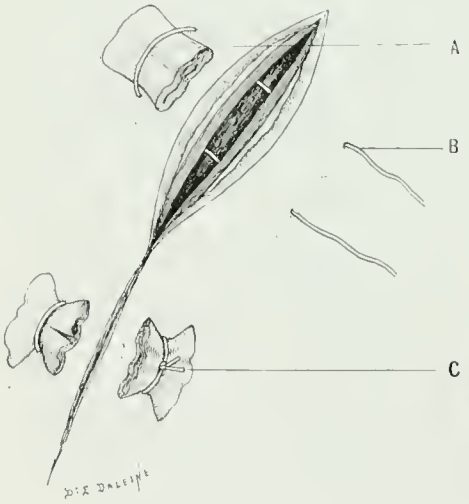


Fig. 471.—Closure of a deep wound in the soft tissues. Transverse loop sutures. (A) A pledget of gauze interposed between the skin and the median loop of the suture. (B) The transverse loop suture. (C) The suture knotted over a roll of gauze.

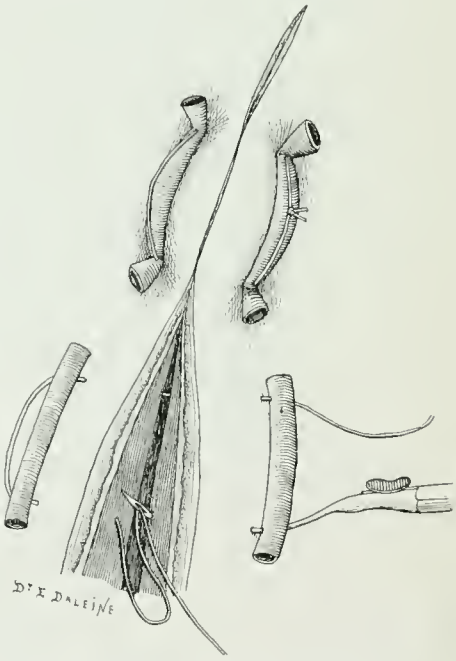


Fig. 472.—Closure of a deep wound in the soft tissues. Interrupted quilled suture.

If there is much tension, reunion will be difficult, and the suture threads will break or cut into the tissues. Some form of supported suture is then very useful. *Figs.* 471 and 472 will indicate the methods of introducing

these sutures better than any verbal description. The little pledgets of gauze interposed between the thread and the skin over which the suture is tightened contribute to the coaptation of the wound edges, and at the same time serve to prevent the skin from being cut; the lengths of catheter represented in *Fig.* 472 act in the same way as the gauze pads, and have the additional advantage of allowing a greater breadth of tissue to be included in each loop of suture.

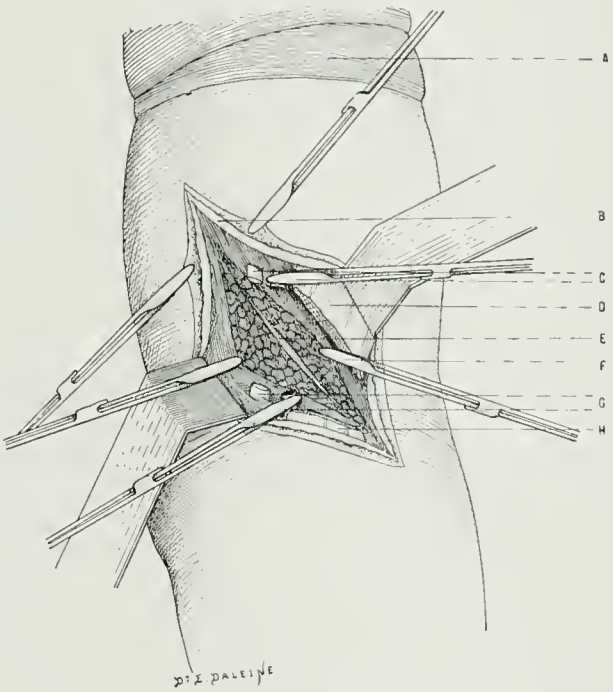


Fig. 473.—Deep wound at the bend of the elbow. 1st step: Hæmostasis. (A) Elastic band. (B) Deep fascia. (C) Brachial artery (upper end) secured with forceps, and median nerve. (D) Upper end of the biceps tendon. (E) Periosteum. (F) Forceps applied to a muscular artery. (G) Lower end of the median nerve, and forceps applied to the lower end of the brachial artery. (H) Lower end of the bicipital tendon.

The latter is, one might say, an interrupted quilled suture, and its application is generally easier than that of the ordinary quilled suture as usually executed with two long rods or long pieces of catheter lying parallel to the margins of the wound.

Once adequate coaptation of the deep parts of the wound has been assured, it only remains to adjust the edges of the skin by a sufficient number of superficial sutures

(*b*). These methods are not applicable in regions containing important vascular or nervous structures, or when the wound is too deep for the supporting sutures conveniently to grasp all the layers.

An illustration will show what is the best line of treatment in such circumstances.

The patient has received a knife-cut in the bend of the elbow, going down to the bone and dividing everything: basilic vein, bicipital tendon, brachial artery, median nerve, and brachialis anticus.

An elastic band or an improvised tourniquet is placed around the upper part of the arm. The two ends of the brachial artery are caught with pressure-forceps, the muscular branches are also secured, the wound is

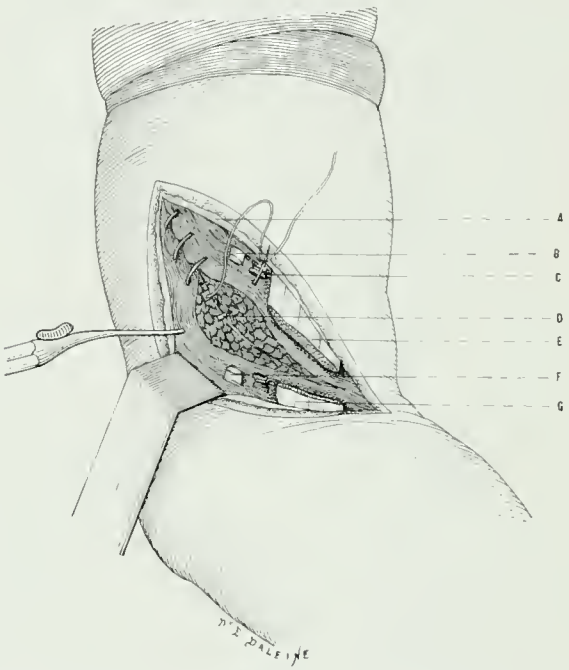


Fig. 474.—Deep wound at the bend of the elbow. 2nd step: Ligation of the vessels and reunion of the muscular layers. (A) Deep fascia. (B) Upper end of the median nerve. (C) Brachial artery, tied. (D) Continuous suture uniting the muscle layer. (E) Upper end of the biceps tendon (F) Lower end of the median nerve. (G) Lower end of the biceps tendon.

thoroughly cleansed, sufficiently exposed, and the divided structures are identified (*Fig.* 473).

Begin the work of repair by reuniting the deep muscular layers. That is best done by means of a continuous suture of catgut or silk, applied from above downwards, and including the whole thickness of the muscle in its stitches (*Fig.* 474).

The ends of the divided artery and its accompanying veins have been tied. Suture the median nerve carefully (see WOUNDS OF NERVES), flexing the elbow so that the two extremities may be brought together without tension. Reunite the large tendon of the biceps by means of a supporting and some superficial sutures. The next step consists in bringing the edges

of the fascial covering of the arm together by means of a second continuous suture (*Fig.* 475), and lastly, the skin is sutured (*Fig.* 476).

If the wound is aseptic, or if the cleansing has been adequate, the best and most rapid results, anatomically and functionally, are obtained by this restoration of the divided tissues layer by layer. Of course, the median nerve will not recover its physiological powers at once, but still, by careful primary suture, it will be placed in the most favourable conditions for speedy regeneration.

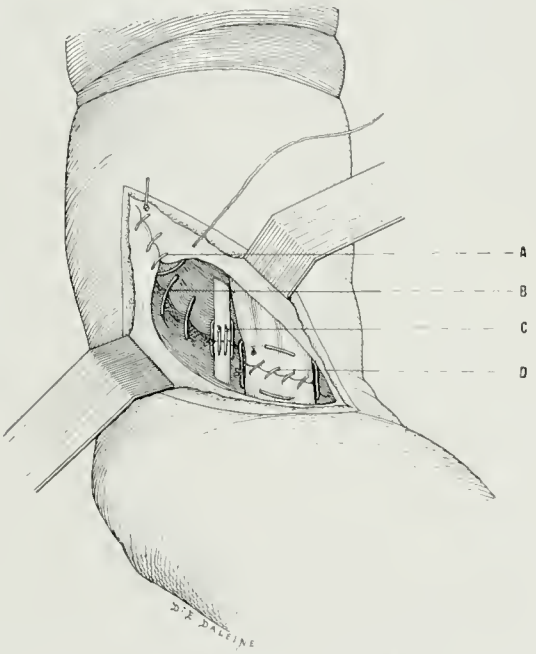


Fig. 475.—Deep wound of the bend of the elbow. 3rd step: Continuation and end of the deep suturing. (A) Continuous suture of the deep fascia. (B) Continuous muscular suture. (C) Median nerve reunited. (D) Bicipital tendon reunited.

In the regions where several muscular layers are superimposed, in the loins, the abdominal wall, and the extremities, this method of reunion in layers insures sound healing, and is really reparative in the strict sense of the word.

But one condition is essential: *asepsis of the wound.* If the accident has occurred some hours previously, if the wound has been contaminated, and if there are any doubts as to the efficacy of the disinfection, leave a drain at the lower angle of the wound; it will be removed at the end of forty-eight hours if the temperature remains normal.

I say a drain; I do not mean a strip of gauze or gauze packing; gauze packing, no matter how loose it may be, does not drain, and in a septic wound it simply acts as a plug and aggravates the local condition.

2. **Contused Wounds.**—Here the treatment must be quite different ; the tissues do not lend themselves to any attempts at primary repair, and, on the other hand, the conditions are much more favourable for the development of septic complications than is the case with incised wounds.

Therefore do not seek to repair the damaged tissues, but pay attention to the cleansing and disinfection of the damaged area and its deep or subcutaneous prolongations.

If the cutaneous wound is relatively small, do not hesitate **to enlarge it freely**, especially in its lower part into the dependent zone, where no cul-de-sac should be left. Time will really be gained by laying the whole area widely open, and satisfactory healing will be more rapidly obtained.

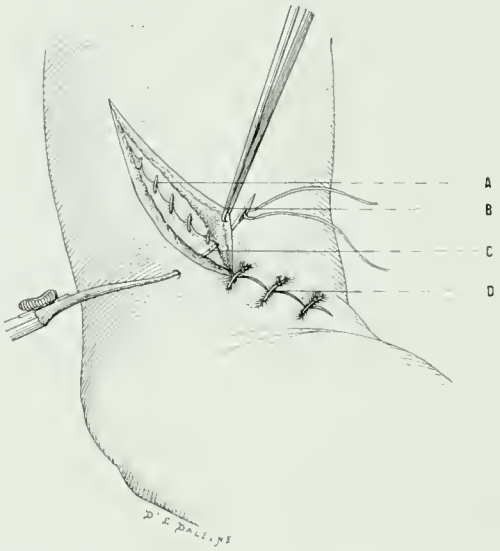


Fig. 470.—Deep wound of the bend of the elbow. 4th step : Closure of the skin wound. (A) Continuous suture in the deep fascia. (B) Edge of the skin wound raised and steadied with dissecting forceps. (D) Interrupted sutures.

Clear the traumatic focus of the clots and débris which it contains, cleanse all its recesses, dry it ; do not attempt to trim it too much by excising this or the other strip or tag of tissue : such attempts always cause bleeding and delay. Arrange a drainage tube carefully, right to the bottom of the cavity and emerging from the lower angle of the wound, and over the tube in the rest of the cavity place some strips of aseptic gauze.

When there is very extensive separation of tissue-planes, several counter-openings at the bottoms of dependent pockets will be required, and provision must be made for multiple drainage.

This line of treatment becomes even more imperative when the damaged area is already infected and suppuration is impending.

In suppurating wounds, after minute cleansing and the provision of drainage, a moist dressing should be applied, but **it should never be**

covered with a layer of impermeable material. The layers of sterile moist gauze should simply be covered with a thick layer of absorbent wool and the whole dressing secured in place with a bandage. In fact the dressing ought to be essentially an agent of absorption, of slow and continuous drainage; it can only fulfil these functions if the fluid which is absorbed by its deep surface can evaporate freely from the outer surface. Impermeable material interferes with this necessary evaporation.[1]

We must mention the frequent gravity of **bites and stings**, certain varieties of which demand special treatment. This is the case with the **poisoned wounds** caused by the bites of vipers or scorpions in our country or of serpents in other parts of the world. Calmette's serum is an antidote to the poison, and may prevent death if injected within four hours from the time at which the bite was received.

Every practitioner, especially in certain countries, should have some flasks of the anti-venomous serum; every hunter or traveller ought also to be provided with it. In hermetically sealed flasks, and if protected from light, the serum will retain its efficacy almost indefinitely, and it is not altered by temperatures below 140° F.[2]

The following is the treatment to be adopted after a snake bite:—[3]

Apply a tight circular ligature above the wound at once, and as close to it as possible.

Make the wound bleed, open it up, expel the fluids by pressure, wash it thoroughly. Use neither ammonia nor antiseptics, which are useless, nor the cautery nor caustics. If no serum is available, or while awaiting its arrival, the best plan is to wash the wound with a 2 per cent solution of calcium hypochlorite, or in default of it, with diluted Javelle water. An ordinary absorbent dressing without any impermeable material is applied.

The serum is injected as soon as possible, in a dose of 10 cubic centimetres, the dose being the same for both children and adults, and after a bite from a large serpent it will be well to give a double dose, 20 c.c., at once. The serum is injected deeply into the subcutaneous tissue of the flank, with a boiled syringe and after due preparation of the skin. In a case of extreme urgency these aseptic preliminaries will be omitted; in such circumstances the serum may be injected directly into a superficial vein, a vein on the dorsum of the hand for instance.

3. **Crushes of the Soft Parts.**—These are crushes which have left the bones intact, and what has already been said with regard to extensive crushing injuries of the extremities is applicable in a certain measure to crushes limited to the soft tissues.

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[1] See our paper, "Le traitement des plaies infectées," *Congrès international des sci. méd.*, 1900.

[2] The serum has been found unaltered and of normal potency in flasks which had been in India for two years.

[3] From the Instructions published by the Pasteur Institute in Lille, and from additional information kindly supplied by Prof. Calmette.

As a matter of fact, the lesions are sometimes quite as serious, and compromise the vitality of the limb in an equal degree. The skin is split, lacerated, and burst at several points, it is separated from the underlying tissues for a considerable extent, both vertically and laterally ; the muscles are torn and converted into a sort of blackish pulp, the arteries are ruptured. *The prognosis to a very great extent depends on the state of the vessels and nerves.*

If they are intact, if the pulse and sensibility are preserved below the damaged area, and *if the skin is not separated in too great an extent circularly*, local repair may be hoped for and, in young subjects especially, sometimes occurs in most remarkable fashion.

As a general rule, immediate amputation is not to be recommended ; even less than in crushing injuries involving the bones along with the soft tissues should primary amputation be done, apart from those exceptional indications which we have already mentioned. Even when the member seems absolutely lost, and the arterial pulsations can no longer be felt, the advantages lie in waiting until the line of demarcation has made itself perfectly evident ; by so doing the sacrifice of tissues will always be lessened.

But this treatment is only rendered justifiable by long-continued and minute disinfection of the damaged area and "embalming" in the manner already described.

The following case will serve to show what ought to be done and what results can be obtained in these extensive crushes of the soft parts, even when they are infected, and when amputation appears at first sight to be necessary.

Case 32.—A lady was knocked down by an omnibus, and her right leg was injured by the wheels ; a dressing was applied. When I saw her thirty-six hours later, the limb was in the following condition : a long and oblique wound with greyish and lacerated edges extended from the outer aspect of the heel to the middle part of the crest of the tibia ; around and above the wound the skin was stripped up as far as the popliteal space, and only remained attached on the inner side in a very small area ; it was marbled with purple and brownish patches ; at the bottom of the wound the torn aponeuroses, the naked tendons, and the ruptured protruding muscles could be seen. The whole of the exposed surface was covered with a sort of dirty, evil-looking false membrane, which also extended in the direction of the calf, whence reddish, sanious fluid escaped. The temperature was 102°, the pulse fast, the face pale and drawn ; even in the short time that had elapsed since the accident the infection had assumed very threatening characters. The bones were, however, intact ; there was no fracture ; the fibula was exposed in its lower third and torn at the extreme tip : that was all.

I wished to avoid amputation if possible ; therefore the patient was anæsthetized, the whole leg was washed with soap and water, with alcohol and ether, and irrigated with very hot boiled water ; then, with the thermo cautery, I incised the separated skin up to the popliteal space, and on the outer side to the knee ; in the deep tissues I laid open several long infected tracks, and some deep punctures around the infected focus terminated this somewhat barbarous-looking measure. Of skin, there only remained a band along the inner surface of the tibia.

Lastly, the whole of the vast raw surface was washed with solution of peroxide of hydrogen, dressed with gauze wet with the same solution, and enveloped in a thick layer of absorbent wool. The dressing was changed daily at first, then at longer intervals. The infection subsided, the sloughs separated, slowly the wound filled up, and three months later the granulating surface was covered with Thiersch grafts, and complete healing speedily followed.

BURNS.

Every burn ought to be considered as an infected wound, and treated as such. The general rules which we have formulated above are therefore completely applicable to burns—to all burns; Mme. Nageotte-Wilbouchewitch[1] is entitled to the credit of showing that rapid, complete, and uncomplicated healing in these cases is not a matter of topical applications.

The agents which have been used in the treatment of burns are very numerous; I need say nothing about the classical Carron oil, but picric acid, thyol, ichthyol, pyrogallic acid, and many others have from time to time been lauded for their keratogenetic properties. Without in the least denying their special virtues, I consider (and experience will speedily convince any one of the truth of what I say) that the best means of relieving the pain of a burn is by preventing infection of the burnt tissues; that the best means of obtaining rapid healing, and a sound, healthy scar, is to protect the natural reparative processes from any septic or chemical interference.

The aseptic treatment of burns is the best treatment, and should be strictly carried out from the beginning.

Take, for instance, a very extensive burn of the right side of the trunk, of the axilla, the inner aspect of the arm, the shoulder and the root of the neck: a recent burn of the first and second degrees in the greater part of its extent, but of the third degree in places; the surface is of a deep red colour, and is studded with numerous blebs, of varying size and colour, which are for the most part still intact,[2] while here and there some dry, yellowish-brown patches indicate deeper destruction of the skin.

To do the work completely and satisfactorily, give an anæsthetic if the burn is large; give it always in the case of children. It is invariably worth the trouble, and under general anæsthesia alone will complete, minute, and prolonged cleansing of the damaged areas and the satisfactory application of the dressing be possible.

First the surrounding region, then the burnt area, must be dealt with in exactly the same manner as the skin is prepared before an operation; and here again, greater dependence is to be placed on mechanical cleansing than on the use of antiseptic agents.

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[1] Mme. Nageotte-Wilbouchewitch, *Traitement antiseptique des brûlures*. Thèse de doct., 1893.

[2] A rare and fortunate circumstance: too often in careless removal of the clothes the epidermis is torn away.

Several pints of warm boiled water, soap, a boiled brush, ether or alcohol, some boiled swabs: that is all that is needed.

Soap and brush widely round the damaged area; penetrate into all the cutaneous folds, between the fingers or the toes; pay particular attention to the borders of the nails; finish the cleansing with ether, which dissolves the grease, and frees the epidermis of the blackish, sticky, dirty layer which clings to the hands and feet of some individuals engaged in certain occupations.

Prepare the burnt surface with the same care. With a boiled swab,[1] and an abundant lather of soap, rub the reddened and blackened skin; rub gently, but prolong the rubbing, cleanse carefully around the blebs, open them with a touch of the thermocautery point, but try to avoid removing the thin layer of epidermis with which they are covered. Pursue this cleansing systematically, area by area; then wash the whole surface with boiled water; not a short superficial irrigation, but a thorough washing of each segment of the skin with water and gauze.

This is a definite mechanical task which requires patience and time; to do it well, half or three-quarters of an hour will sometimes be necessary; boiled water, or better still, boiled salt solution, is the medium to be preferred.

Apply nothing more than a dry, sterile dressing. I do not say that picric acid and many other agents are actually harmful, as carbolic acid, sublimate, and iodoform undoubtedly are when applied to a large raw surface; I simply say, after an extensive experience of it, that the aseptic treatment, if carried out with minute attention to detail and begun by a prolonged mechanical cleansing, insures more rapid healing and a better scar.

Cover the burn, therefore, with dry sterile gauze; if none is at hand, use boiled compresses, well wrung out; apply nothing else to the surface if the skin is but little denuded; if otherwise, cover the raw places with a little sterilized vaseline, to prevent the gauze from adhering. Over the gauze put on a thick layer of sterilized absorbent wool and a flannel or crêpe bandage which covers in the dressing completely and exercises moderate and uniform pressure: of course, **never any impermeable material in the dressing.**

This is, in short, the ordinary dressing for a recent, simple wound, and as a matter of fact, by the careful preliminary attention the burn has been converted into a wound of that type. The dressing will be left untouched as long as possible: eight, ten, twelve days if there is no rise of temperature; and often, when it is removed, the skin underneath will be found dry, smooth, and already regenerated.

This treatment is not applicable merely to burns of the first three degrees; it can be used with equal advantage in **deep burns** with large sloughs. We can remember the interminable suppurations which used to

[1] Not with a brush: the brush should only be used for the cleansing of the surrounding area: the burned surface should not be brushed.

be associated with the elimination of the dead tissues, the long-continued hectic fever, and the not uncommon fatal issues. Nowadays there is no need to emphasize the fact that suppuration and the separation of sloughs are not two necessarily associated processes; if the aseptic treatment is instituted at once and adequately carried out, the necrotic areas will separate and healing ensue without suppuration.

In dealing with a serious burn of this kind, devote every attention to carrying out at once the "preparation" which we have just described, but carry it out even more completely and scrupulously. There is no need to be specially considerate of the damaged skin, for it is in great part destroyed; soap and brush the entire surface, therefore, rub it with alcohol and ether, wash it with boiled saline solution, and once this rather rough cleansing is completed, apply a dry aseptic dressing as before.

For deep burns by incandescent wires, such as are sometimes seen amongst wireworkers, it will be well to adopt the line of treatment recommended by Sczypiorski; the whole cauterized zone is excised with scissors or knife, going if necessary right down to the bone, which will in that case also be scraped; in this way a wound with bleeding, healthy walls will be obtained, the successive planes (muscles, tendons, fasciæ, skin) of which can be sutured, and which will heal by first intention.[1]

The situation is somewhat different in the case of **a burn of some days' standing**, badly treated, contaminated with various local applications, oily applications particularly, and **already suppurating**.

Antiseptics are no more useful than in the preceding conditions. These infected burns are best treated like any other infected wounds (see above): therefore, apply the general treatment already outlined; open up all suppurating pockets, lay the whole surface bare, and prolong—under anæsthesia—the mechanical cleansing. But in this case terminate the operation with the application of a moist, sterile dressing of boiled gauze and absorbent wool, without any impermeable material.

When the burn is very extensive, it is not always of the same degree, nor everywhere equally contaminated; it will then be good practice to apply the dressing *in segments*, for the purpose as far as possible of preventing the contamination, under the same covering, of the easily curable zones by the infected and suppurating areas. Lastly, in the very enormous burns which affect a large part, sometimes almost the whole of the surface of the body, the aseptic method is still the best; it may be necessary almost completely to envelop the patient in the aseptic dressing. In such cases prolonged tepid baths are also of very real service.

I need merely mention the general complications of the extensive burns: the **initial shock**, best treated by injections of normal salt solution, the administration of which may with advantage be continued by the rectum or subcutaneously, after the stage of shock; the always threatening **visceral congestions**, and the **local complications** such as œdema of the glottis (see Vol. I., p. 177).

[1] Sczypiorski, *Soc. de Chir.*, 8 juillet, 1903, p. 760.

WOUNDS AND RUPTURES OF THE GREAT VESSELS. TRAUMATIC HÆMORRHAGES.

In the great traumatic hæmorrhages there is a first line of treatment—first aid on the scene of accident—which does not always fall to the lot of the medical man. A knowledge of the necessary measures cannot be too widely diffused; these measures are within the powers of every one, and I add that it is the duty of every one to put them in practice should occasion arise. Even in the great centres of population, do we not see injured persons die whose lives might have been saved by the slightest initiative on the part of the first comers?

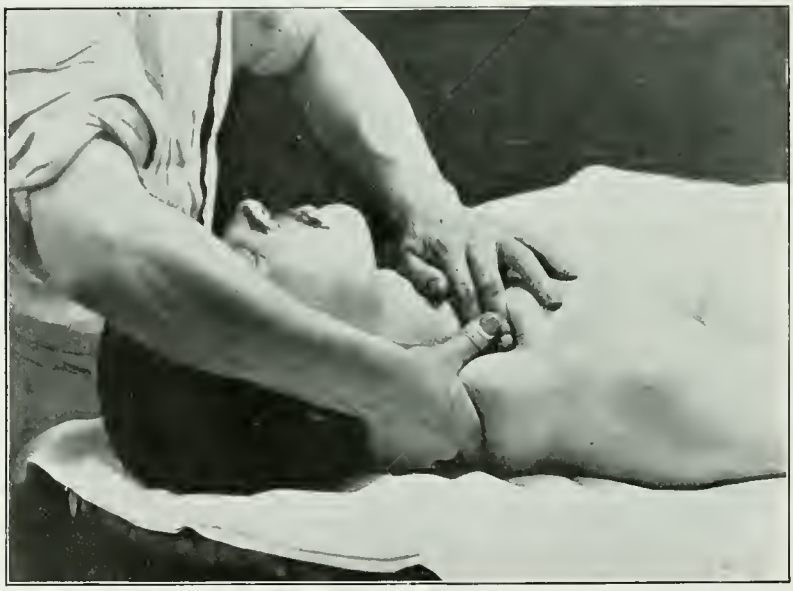


Fig. 477.—Compression of the subclavian artery.

I can hardly cite a more striking illustration than that of an unfortunate carter who, having fallen from his vehicle, had his right thigh crushed and the femoral artery torn, and was immediately picked up and transported to the Beaujon hospital, bleeding profusely all the time, without any person making the slightest attempt to check the hæmorrhage; he arrived exsanguinated, pale, cold, and pulseless, and it was only by the unexpected triumph of intravenous injection of saline solution, repeated during the course of the day, that he was rescued from impending death.

Temporary Hæmostasis.—What is to be done then with a wound which is bleeding in jets? **Apply pressure above, and not to the wound itself.** Compress above, at once, instinctively, with both hands grasping the entire circumference of the limb if possible, while some one else encircles the limb with a strip torn from a garment, a rolled towel or handkerchief, a fairly thick cord of any kind, ties it, slips a piece of wood, the shaft of a hammer, or any available rod, under the knot and twists it to tighten the band still further, so improvising a tourniquet.

Fig. 478.—Esmarch's brace.

We have thought it advisable to illustrate *Esmarch's brace*, which might be very useful in "first aid" if it were commonly worn by medical men, hospital assistants, workers in factories, railway men, etc.[1] Shortly, it consists of an elastic band, provided with a series of holes and a hook at each end; *Fig.* 478 shows the very simple way in which it is adjusted in ordinary circumstances; it is then simply a brace, and an excellent brace.[2] In a moment it may be converted into a not less perfect hæmostatic band (*Fig.* 479).

Circular compression above the wound can be effected by any one and everywhere—and if it is properly done it meets the exigencies of the

[1] M. Ch. Périer has strongly recommended this general use of Esmarch's brace.

[2] On this point I can add my personal testimony to that of M. Périer.

case in the best possible manner *by achieving provisional hæmostasis without the wound being touched.*

Fig. 479.—Esmarch's brace used as a hæmostatic bandage

Fig. 480.—Compression of the femoral artery in the groin.

Do not touch the wound: that is the second rule to be laid down for what one may call the public treatment of these cases. How many

disasters would be avoided if it were generally known that, to arrest hæmorrhage, it is illusory and dangerous to introduce dirty hands into the

Fig. 481. Compression of the brachial artery at the inner aspect of the arm.

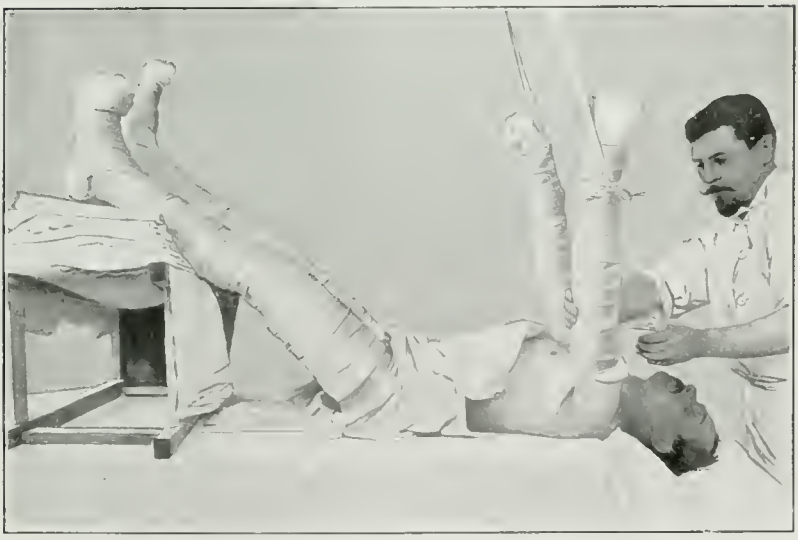


Fig. 482.—Auto-transfusion in acute anæmia.

wound, to stuff rags or lint and the rest into it, to pour in fluids of all sorts, and which it is just as well not even to mention.

At the roots of the limbs, however, in the groin or the axilla, direct

Fig. 483.—Provisional hæmostasis.
1st step: Elevation of the limb; displacing the blood towards the body.

Fig 484. Provisional hæmostasis. 2nd step: Application of the elastic bandage

compression in the wound is sometimes the only possible course; in such

a case the cool-headed man who springs to the patient, tears open his garments, and applies his thumb or both thumbs broadly to the gaping wound, is acting in the true surgical spirit.

And as a matter of fact the surgeon does much the same in dealing with an arterial wound. He compresses the principal artery of the limb above the wound at the points of election ; against the inner surface of the humerus (*Fig.* 481), on the 1st rib (*Fig.* 477), against the inner surface of the femur along the line of Hunter's canal, or on the ileo-pectineal eminence (*Fig.* 480). Then, if a reliable assistant is available, the temporary digital compression is entrusted to him, or provisional hæmostasis is insured by means of Esmarch's or any other elastic band (*Figs.* 483, 484).

Figs. 477 and 480 show the methods of efficiently compressing the subclavian, or the femoral artery in the fold of the groin ; lastly, compression of the aorta (*Fig.* 485) may be a life-saving procedure in some cases of profuse hæmorrhage of pelvic origin.

Fig. 485. Compression of the aorta.

Let us add that, in the presence of symptoms of intense acute anæmia, and when death seems impending, recourse must be had at once to auto-transfusion (*Fig.* 482) by lowering the head and elevating the limbs, enveloping them with wool, and compressing them by bandaging from the digits to the trunk : to intravenous infusion of saline solution, hypodermic injections of ether, caffeine, etc.

That is the first step, the treatment of instant necessity, if one may use the expression ; it is then necessary to proceed to the measures for insuring *permanent hæmostasis.*

Permanent Hæmostasis.—The rule is simple and constant : **ligate, in the wound, the two ends of the wounded artery.** If the vascular lesions are multiple, apply forceps, and then tie everything that bleeds.

At the present day, thanks to Esmarch's bandage and pressure-forceps the undertaking is greatly simplified ; reading the old records, one cannot

but unreservedly admire the coolness, the deftness, and the high craftsmanship of the surgeons who, ill-equipped though they were, nevertheless, succeeded in conquering the most terrible hæmorrhages.

Better assured of immediate success, we ought to devote all our efforts to rendering ultimate success certain, by excluding all causes of secondary hæmorrhage and, most important of all, sepsis.

Temporary hæmostasis having been achieved by the elastic band or digital compression, begin by preparing the wound and the whole surrounding region with the usual scrupulous detailed attention.

The bleeding has ceased; therefore, to neglect all the rules of surgical cleanliness under the pretext that a large artery is wounded is absolute nonsense and a grave imprudence. Of course, if an artery is spouting under his eyes, the surgeon will not go to wash his hands before compressing it, and if a pressure-forceps is at hand, he will only be too glad to use it, though neither flame-sterilized nor boiled. All this is indisputable, but it would be wrong to go further on these lines than vital necessity demands. Do not be in a hurry, therefore; cleanse the wound thoroughly, enlarge it as far as is necessary in order to see clearly, and seek for the upper end of the artery, seize it with forceps, seek for the lower end, which is sometimes considerably retracted within its connective tissue sheath, and secure it in its turn.

Do not apply the forceps indefinitely to the whole group of vessels *en masse*; the provisional hæmostasis, if it has been properly effected, will enable one to do better, to seize the artery alone, if it alone is injured, without lacerating or tearing the accompanying vein and without risk of bruising the adjacent nerve trunks.

But often the great artery is not the only vessel wounded; other smaller branches are frequently injured and bleed, and in spite of the compression above the level of the lesion, the oozing is sometimes so profuse that it is difficult to recognize the structures at the bottom of the gaping wound; in such circumstances the best procedure consists in plugging the cavity with aseptic gauze, applying firm pressure on the plug for a minute or so, and then raising it gradually by one of its edges and securing each bleeding point as it comes into view.

When the most important vessels have been caught, the elastic band is removed, while the surgeon, forceps in hand, watches the surface of the wound, ready to seize anything which begins to bleed. In deep wounds of the groin and axilla, where the upper end of the divided vessel is sometimes difficult to find, help can be obtained by momentary relaxation of the digital compression of the main arterial trunk; a jet of blood appears and indicates the position of the injured vessel. But much time—and blood—is lost by these complex manœuvres, and the best plan is to enlarge the wound as freely as may be necessary at once, by incising the anterior wall of the axilla or Poupart's ligament (*Fig.* 486), as the case may be, or, again, to **expose the main trunk** higher up and **to ligate it in continuity**: in other words, to ligate the subclavian or the external iliac.

Once hæmostasis has been assured by ligature at a distance, it is necessary to return to the traumatic focus, to open it up, cleanse it, and to

seek for the ends of the divided vessels, and particularly the upper end of the chief vessel, all of which must be caught and tied. This step is absolutely necessary if the danger of secondary hæmorrhage is to be avoided.

Deep Wounds of the Hip, implicating the gluteal, the sciatic, or internal pudic vessels, are particularly serious, and necessitate very troublesome operations. Several conditions may present themselves: (*a*) The wound is of some length and is bleeding profusely; (*b*) The wound is small, the external hæmorrhage not great, but all the signs of internal bleeding

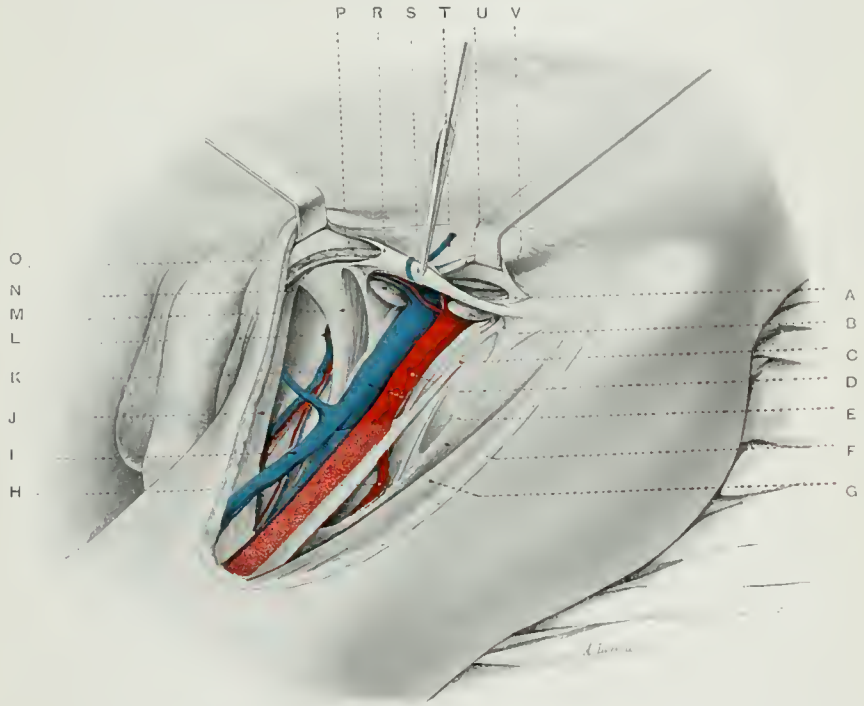


Fig. 486.—Inguino-crural region. (A) Origin of the deep epigastric artery. (B) First external iliac lymph ganglion. (C) Anterior crural nerve. (D) Femoral artery. (E) Femoral vein. (F) Ilio-psoas muscle. (G) Sartorius muscle. (H) Deep femoral artery. (I) Internal saphenous vein. (J) Adductor longus muscle. (K) Obturator vessels. (L) Obturator foramen. (M) Pectineus muscle. (N) Cloquet's lymph gland in the crural canal. (O) Spermatic cord. (P) Gimbernat's ligament. (R) External inguinal ring. (S) Poupart's ligament raised by forceps. (T) Aponeurosis of the external oblique muscle. (U) Lower border of the internal oblique and transversalis muscles. (V) The aponeurosis of the external oblique incised at the site of the deep inguinal ring, and retracted.

and rapidly advancing anæmia are present; in such circumstances the artery has usually been wounded at the level of the sciatic foramen, and the central end has retracted into the pelvis; (*c*) The wound is small, the primary hæmorrhage small in amount and easily arrested, but at the end of some hours, or perhaps a few days, the region has become distended with a pulsating tumour which increases steadily in size; the swelling is a diffuse aneurysm (see p. 521). In the two first hypotheses it is necessary to act at once, and the wisest plan is to try first of all to tie

the two ends in the wound by making a very free incision in the gluteus maximus, so as to expose the sciatic foramen completely. Should it be found impossible to secure the central end by this route, then **the internal iliac artery must be ligated** forthwith. Of course, if the wound in the hip is "penetrating," and there are signs of intraperitoneal hæmorrhage, or a lesion of some pelvic organ, the abdominal route will be adopted in the first instance.[1]

We cannot here describe the technique of these classical ligatures; we shall merely say, that in urgent conditions, operating in a region often infiltrated with blood, **large incisions** are essential for recognizing the landmarks definitely and saving time.

Further, in tying the two ends in the wound or the main trunk in continuity, great care must be devoted to the ligature; a double thread will be passed under each end, the first thread will be tightened slowly and steadily, and knotted, then above it and in close contact the second thread

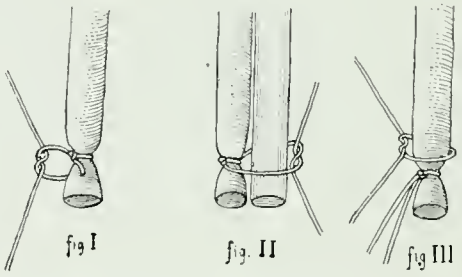


Fig. 487.—Methods of ligating the large vessels (diagrammatic). *Fig.* I.—Simple ligature; one of the ends has been passed through the stump of the vessel, to be knotted at the side with the other end. *Fig.* II.—Ligature securing a large artery and a large vein. *Fig.* III.—Double ligature of a large artery.

will be tied in the same manner (*Fig.* 487, III). This excellent plan was recommended by M. Lucas-Championnière, and personally I always employ it; it is especially valuable in tying a diseased artery, the atheromatous, friable artery of an old man, or, again, when operating for secondary hæmorrhage, on a softened and infiltrated arterial wall. The safety of the ligature may also be assured by passing one of the ends of the thread through the vascular stump, and knotting it at the side with the other end (*Fig.* 487, I). Lastly, when it is necessary to tie both the large artery and the large vein, it is a good plan to consolidate the two ligatures as shown in *Fig.* 487, II.

In following the recommendations which have just been expressed, hæmostasis will always be effected by ligature, the surest method at the time of operation and afterwards.

[1] See R. v. Varendorff, *Ueber die Verletzungen und Aneurysmen der Art. glutæa und ischiatica.* In. Diss. Marburg, 1899; and H. Pelizza, "Quelques considérations sur les plaies de l'échancrure sciatique." Thèse de Paris, 1900, No. 97.

I believe that it is necessary to restrict the application of **continued forcipressure** as far as possible; it is a useful method, sometimes a life-saving method, in certain conditions, at the bottom of deep cavities, and when it is impossible to do better, but it is also often uncertain and dangerous. A good ligature, properly applied and perfectly aseptic, becomes continuous with the wall of the vessel and does not slip; a pressure-forceps or a clamp left in position, however carefully it may be supported by the dressing, may be displaced or torn off by a movement of the patient, and besides, the possible recurrence of bleeding on the removal

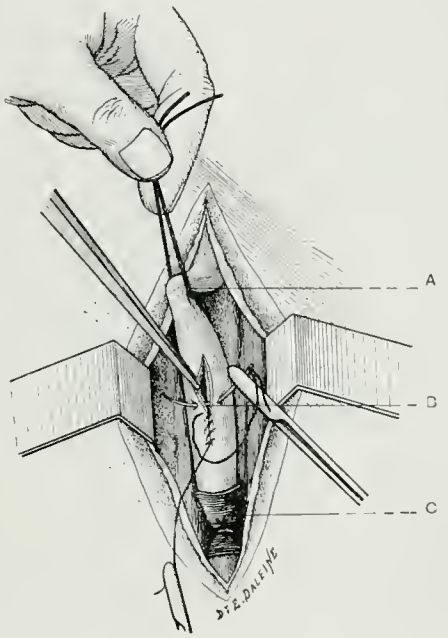


Fig. 488.—Arterial suture (femoral). First continuous suture. (A) Stout thread kinking the upper end and so effecting hæmostasis. (B) Needle traversing the two edges of the arterial wound without perforating (so far as possible) the inner coat. C) Temporary ligature of the lower end over a strip of drainage tubing.

of the forceps, a condition which is by no means uncommon, must be taken into consideration.

With regard to **compression**, it should only be employed in dealing with diffuse oozings, especially venous, which persist after ligation of the large vessels. We shall describe immediately a very valuable procedure in treating these diffuse hæmorrhages.

If **a large vein** is wounded, with the artery or independently, the same rules apply as in treating a wounded artery: **both ends must be tied.**

I have already said elsewhere that a wound of a large vein, the internal jugular, the subclavian, the femoral, etc., often occasions greater difficulties to the surgeon than one of the corresponding artery; the vein collapses, the hæmorrhage is diffuse and continuous, and the search for the two ends is

often difficult. In such circumstances pressure must be applied above and below the wound, circularly if a limb is affected, and the artery will be used as a guide to the ends of the divided vein.

If the wound involves only a part of the circumference of the vessel, if it is oblique or longitudinal and comparatively short, one may feel tempted to try a lateral ligature; it is a bad method, which gives only very doubtful security. Put a forceps on the laceration without occluding the lumen of the vessel, but do not tie a ligature around the segment of the wall which is grasped; if suture is impracticable (see later), **pass a double ligature under the venous trunk and tie it above and below the point of injury**[1]

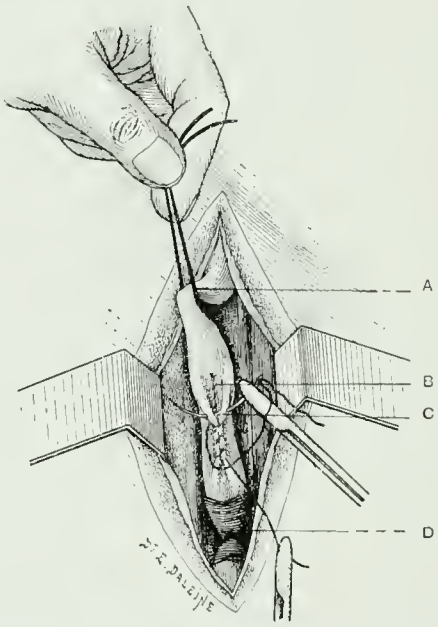


Fig. 480. Arterial suture (femoral). Second continuous suture. (A) Thread kinking the upper end. (B) Deep suture. (C) Needle passing through the tunica adventitia and introducing the second continuous suture. (D) Temporary ligature of the lower end over a strip of rubber tubing. (One of the great defects of arterial suture is evident; the reunion is good, but the calibre of the artery is very greatly diminished).

In the case of a small wound, or a perforation of a large artery or vein, suture may be attempted.

Arterial suture has given some successful results on the axillary, the external iliac, and the femoral. I refer to lateral suture[2] of a short

[1] This applies even to the inferior vena cava, as Houzel has shown ("De la ligature des veines et, en particulier, de la veine cave inférieure." *Revue de chir.*, 1903, No. 3, p. 287; and No. 4, p. 455.)

[2] Circular suture has been performed five times; M. Delanglade has reunited, end to end, the radial and ulnar arteries, which had been divided about two inches below the elbow; the suturing was done with No. 00 silk; it was easy, and the suture line remained tight; but the pulsations did not reappear in the lower ends, and the radial pulse was permanently abolished. (*Bull. de la Soc de chir.*, 8 avril, 1903, p. 401.)

wound, longitudinal or only slightly oblique; naturally there are great advantages in preserving the permeability of a large artery, such as the common carotid, ligation of which is not free from danger. Still, the indications for suture in urgent surgery are very limited, and as a rule it will be better to apply a good aseptic ligature.

As to the technique, it is undoubtedly delicate; the lumen of the artery must be temporarily occluded above and below the point of injury; the two edges of the wound are reunited by a continuous suture of fine silk, with closely-set stitches, which as far as possible are kept from perforating the tunica intima; the external coat and the connective tissue sheath are brought together over the deep line of suture by a second continuous suture; in this way the operator endeavours to get strong, accurate, blood-tight closure of the wound *without too much diminution of the calibre of the vessel* (*Figs.* 488 and 489): shortly, these are the outlines of the method. It is not so much hæmorrhage that is to be feared as thrombosis and secondary embolism.

With regard to **venous suture**, this method is always to be recommended in suitable cases, and many successful cases are now on record. Naturally, it is only applicable to longitudinal wounds or to slightly oblique wounds which implicate but a limited part of the circumference of the vessel, and no one would think of recommending it as a method of choice, in urgent surgery especially.

Still, it must not be forgotten that it has given some most successful results; Schede has sutured the inferior vena cava,[1] Ricard[2] the innominate vein. It has also been practised with success on the great veins of the limbs, particularly on the femoral vein.

A case of Jordan's[3] may be quoted as an example: A cold abscess situated in the right supra-inguinal region was incised and scraped; during the scraping, profuse venous hæmorrhage occurred, which pressure was powerless to control, and the patient's condition speedily became most

[1] M. Schede, "Einige bemerkungen über die Naht von Venenwunden." *Arch. f. klin. Chir.*, 1892, Bd. xliii., p. 338. In Schede's case, during the course of the extirpation of a tumour of the right kidney, the wall of the inferior vena cava was torn for the length of three-quarters of an inch; temporary hæmostasis was effected by means of two forceps placed obliquely above and below the gap, and then the two margins of the venous wound were reunited by a continuous suture. There was no recurrence of the hæmorrhage when the forceps were taken off. Death occurred eighteen days later, and at the autopsy the line of union was found perfectly sound.

[2] Ricard, "De la suture appliquée à l'hémostase des plaies accidentelles ou opératoires des gros troncs veineux. *Congrès de chir.*, 1895. In Ricard's first case, the internal jugular vein, which was adherent to the tumour, had been extirpated low down along with a fibro-sarcoma of the thyroid. Considerable venous bleeding occurred behind the sterno-clavicular articulation, but was easily arrested by the application of some pressure-forceps. It was then seen that the loss of substance involved the right brachiocephalic trunk, and that it corresponded to the orifice of the internal jugular vein. "With a fine needle, and removing the forceps in succession, we succeeded in closing the opening with five Lembert sutures of fine silk."

[3] Max Jordan, "Die Behandlungsmethoden bei Verletzungen der Schenkelvene am Poupart'schen Band." *Beitr. zur klin. chir.*, 1895, Bd. xiv., 1, p. 279. See also some other cases in F. Fraenkel, "Ueber die Verletzung der Vena femoralis communis am Poupart'schen Band und deren Behandlung. *Beitr. zur klin. chir.*, 1901, Bd. xxx., p. 81. A. Schönwerth, "Ueber die Naht der Schenkelvene am Leistenbande und ihre Indikationem." *Munch. med. Woch.*, 3 mars, 1903, No. 9, p. 372; three cases of closure of venous wounds with *perforating sutures*, three recoveries. See also Clermont, "Suture latérale ou lointaine des veines." *Presse méd.*, 18 mai, 1901, p. 229.

serious. Jordan began by exposing the vein above Poupart's ligament, and passed a ligature around it, but the bleeding continued; he enlarged the wound in an upward direction and exposed a higher segment of the external iliac vein, and around it passed a second provisional ligature; the bleeding then ceased, and a longitudinal tear about half an inch in length was found on the anterior wall of the vein above Poupart's ligament. The opening was closed by three silk sutures, and over it the connective tissue was reunited by two other sutures. The provisional ligatures were relaxed; no bleeding recurred; but as a safeguard they were left in position and the wound was packed. Recovery took place without any complication.

In executing a venous suture, a fine needle and fine thread are required; either catgut or silk may be used. Provisional hæmostasis is secured by compressing the two ends of the vein with the fingers or by raising them on two directors, and then the opening is closed either by continuous or interrupted suture. According to Schede, it matters little what layers of the venous wall are brought together. The best plan is to enter the needle about a twelfth of an inch from the margin of the opening, and to pass it through the whole thickness of the wall of the vein, bringing it out at a corresponding point on the opposite side; the sutures will be tied gently, but sufficiently close to ensure good adjustment. Over the sutured vein the connective tissue sheath and the adjoining fibrous tissues are reunited.

Finally, and particularly in *diffuse hæmorrhages*, decided advantages are associated with the use of **gelatin**, according to Paul Carnot's method.[1]

The gelatin is in watery solution (or better, in saline solution 7 per mille, or in solution of calcium chloride 1 per cent), in the proportion of 50 grams to the litre (5 per cent); this strength is not absolute, and more concentrated solutions, up to 10 per cent, may be used without disadvantage. The gelatin solution is sterilized twice at 100° C. for a quarter of an hour each time, with an interval of two days. It sets on cooling, and is preserved just as it is; it retains its normal appearance so long as it remains aseptic.

To use it, it is liquefied on a water-bath, care being taken not to overheat it, because it does not act so well when it is too hot; the best temperature appears to be about 140° F.

The solution, to produce its maximum effect, ought to come into contact with the blood escaping from the wound. The method of application is very simple. A sufficient quantity of the solution is poured directly on to the bleeding surfaces, or swabs or strips of gauze may be saturated with the gelatinous liquid and spread over or packed into the wound. The action is usually very rapid.

Although it is possible by this means to check bleeding from comparatively important vessels, it is inadvisable to bring a very excellent

[1] Paul Carnot, "De l'hémostase par la gélatine." *Presse médicale*, 1897, No. 77; and "Indications et contre-indications de l'hémostase par la gélatine." *Presse médicale*, 1898, No. 94

emergency resource into discredit by extending the indications for its use too widely. It gives excellent results in diffuse and profuse oozings, in certain hæmorrhages into cavities, and in some large wounds where it is necessary rapidly to complete hæmostasis after ligature of the principal vascular trunk.

SUBCUTANEOUS RUPTURES OF VESSELS. DIFFUSE ANEURYSMS.

We now approach a second group of traumatic hæmorrhages: the subcutaneous hæmorrhages which follow ruptures of the great vessels, whether lacerated by the fragments in certain fractures, or stretched and torn in a dislocation, either during the attempts at reduction or by the direct action of the injury.

Elsewhere I have discussed these **direct subcutaneous ruptures of the great arteries.**[1]

The following case served as the subject of my paper, and is worth repeating.

Case 33.—It related to a man, 38 years of age, who had been struck violently and knocked down by a heavy waggon; two wheels had passed over his right arm. I saw him two hours after the accident; no radial pulse could be felt, and the ulnar pulsations were also absent; the hand was white, cold, and motionless, and completely devoid of sensation; the fingers were semi-flexed. Sensation was present above the middle part of the forearm, but the skin was cold up to the elbow. No pulsations could

Fig. 490.—Dry gangrene of the fingers secondary to direct subcutaneous injury of the brachial artery above the bend of the elbow.

be felt in the brachial artery at the elbow: and at the inner border of the biceps, along the line of the vessels, there was a soft and œdematous, elongated, ovoid swelling, which extended as high as the middle third of the arm. There was neither wound nor fracture. The limb was enveloped in a thick layer of wool; for quite a long time the hand appeared dead, but ultimately the gangrene limited itself to the index and medius in their entirety, to both phalanges of the thumb, and to the terminal phalanges

[1] "Des ruptures sous-cutanées directes des grosses artères et des gangrènes consécutives," *Revue de chir.*, avril-juin, 1898.

of the ring and little fingers. The gangrenous segments were excised, but many weeks were required before healing was complete. The radial pulse reappeared very feebly only at the end of four months. On the inner aspect of the arm above the elbow a sort of elongated, nodulated cord, which represented the crushed and obliterated artery, could be felt.

The crushing and curling up of the coats of the vessel (*Figs.* 491, 492) sometimes result in complete occlusion of the vessel, and then no subcutaneous hæmorrhage occurs, but secondary gangrene is always to be feared (*Fig.* 490). Of the 34 cases collected by ourselves, four only terminated without gangrene. A very interesting case of G. Michel's should be mentioned: the patient in falling had struck the inner side of his right arm against the edge of a tub; the thrombosed brachial artery was transformed for a length

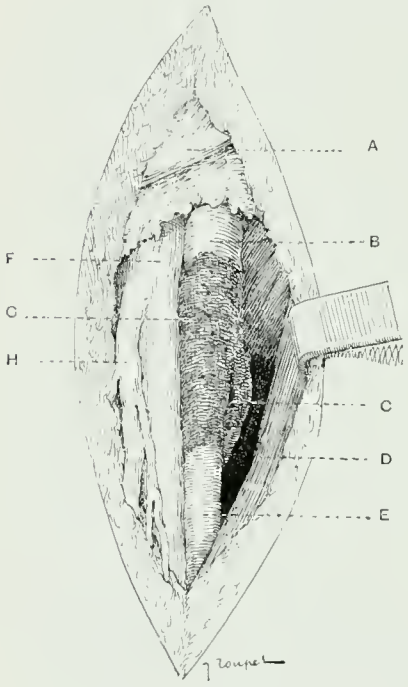


Fig. 491.—Direct subcutaneous crushing of the femoral artery. (A) Poupart's ligament. (B) Femoral artery above the contused segment. (C) Deep femoral artery. (D) Sartorius muscle. (E) Femoral artery below the contused zone. (F) Femoral vein. (G) The contused segment of the femoral artery. (H) The internal saphenous vein.

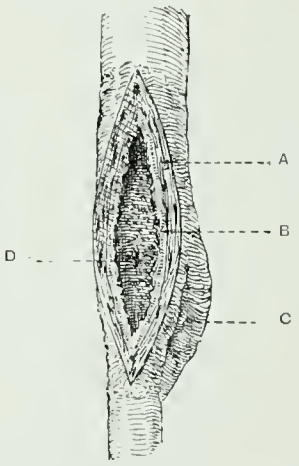


Fig. 492. Direct subcutaneous crushing of the femoral artery. Incision of the contused segment of the artery. (A) Middle coat of the artery. (B) Inner coat. (C) Deep femoral artery. (D) Clot filling the artery in the contused zone.

of about two inches into a hard, very tender cord, the size of a goose quill; there was no peri-arterial effusion. Seventeen days later the radial pulse returned. Recovery took place without the slightest gangrene; but six months later, there was still a hard cord along the line of the brachial artery, the radial pulse was feeble, and the arm was very weak. As Michel remarks, in the five instances of direct subcutaneous rupture without gangrene, in four it was the brachial artery which was affected,

and the favourable issue is probably to be explained by the easy re-establishment of the collateral circulation.[1]

The **absence of the pulse** in the area below the point of injury, the **pallor** and **coldness** of the limb, the **loss of sensation**, superficial and deep, indicate the obliteration of the great vessel. A hæmatoma of variable size, sometimes a simple, elongated tumefaction, or a line of diffuse thickening, indicates the level where the injury has taken place. If the case is seen at once, and all signs indicative of a sudden arrest of the circulation are found, there are two precautions which must always be taken: **the careful disinfection of the skin** and **the envelopment of the limb in a thick layer of wool.** Perhaps—and that particularly when the peri-arterial effusion is considerable—it might be good practice to open up the focus at once, to clear it out and to cleanse it completely, to expose the artery, and tie it above the contused segment.

By so doing all danger of embolism is eliminated, and undoubtedly the extent of the gangrene may be restricted; for, though the gangrene is caused on the one hand by the extensive thrombosis which follows the vascular lesion and the compression exercised on the collateral vessels by the effusion, embolism is also an important factor, fragments becoming detached from the soft thrombus and carried to the periphery, where they are arrested at some one or other point of division of the artery.

Case 34.—In a patient, 35 years of age, suffering from a direct subcutaneous crush of the left femoral artery, the result of a severe blow in the inguino-crural region, and whose lower extremity seemed in imminent danger of gangrene, I made a long incision over the injured area, evacuated a considerable amount of effused blood, and at the centre I found the vessels, separated from the surrounding tissues for a length of 4 inches, black in colour and surrounded by a thick coating of coagulated blood. The vein seemed permeable. The artery was hard, black, thickened for a length of two inches, down to an inch below the origin of the deep femoral (*Fig.* 491). After applying a double provisional ligature, I incised the contused artery longitudinally, removed the clots which plugged it (*Fig.* 492), and closed the arterial wound with a double continuous suture of No. 00 silk. There were no local complications, but the gangrene of the foot and leg was in no way influenced, and I had ultimately to amputate below the knee[2].

When the arterial rupture expresses itself at once by a pulsating hæmorrhagic effusion which increases rapidly in size, causes more or less grave compression, and threatens to rupture—in short, when the signs of **a diffuse aneurysm** are present—the necessary line of action demands much more initiative and presence of mind.

If the surgeon is present at the time of the accident, the first thing to be done is **to compress the arterial trunk above the rupture**; if this action is taken early, if the compression is properly executed and prolonged

[1] G. Michel, "Rupture sous-cutanée directe de l'artère humérale, oblitération consécutive, guérison sans gangrène," *Gaz. des hôp.*, 15 janvier, 1901, No. 6, p. 49.)

[2] "De l'attrition sous-cutanée directe des grosses artères," *Soc. de chir.*, 21 mai, 1902, p. 609.

for several hours, even up to twelve or twenty-four hours, and the rupture is small, it may be possible to check and even permanently arrest the extension of the extravasation. Such a result can, however, scarcely be depended on, and in large ruptures, when the effusion steadily increases, in spite of the compression, it becomes imperative to expose the artery at once above the point of injury and to tie it. Usually, however, *the diffuse aneurysm is already present at the time when the patient is first seen.*

What is to be done in view of the rapid and threatening increase in size of the swelling? Two plans are available: (1) **To tie the arterial trunk (subclavian, femoral, external iliac) above the rupture**; (2) **To compress the arterial trunk above the lesion, or to open up the aneurysm and to ligature the two ends directly.**

The first plan is as a rule the simpler, though the application of the ligature is not always, or even commonly, an easy task in such circumstances, but it is often quite inadequate, particularly when the effusion is great. The compression, the threatening gangrene, the inflammatory complications, and secondary rupture of the diffuse aneurysm, cannot be averted by ligature pure and simple of the upper end.

Open the cavity and ligate the two ends in situ, that is the method of choice; but it must be recognized that it is not an easy operation. It demands a cool head and the help of a good assistant. When, however, the lesion is so situated—a rupture of the popliteal, or the lower part of the femoral, or the brachial above the elbow for instance—that the application of an Esmarch's band above **the aneurysm** is possible, the operation is greatly simplified. But at the roots of the limbs, it is always a dangerous procedure, because the digital compression to which it is necessary to have recourse is much less sure than circular constriction with an elastic band.

Once provisional hæmostasis is established, the aneurysmal sac is opened deliberately, and, without troubling about the stream of blood which gushes forth, the cavity is very quickly evacuated, the clots are removed, the wound wiped out, and the ruptured vessel is sought at once, first the upper end, then the lower one. If the oozing of blood is great, in spite of the compression (digital), the cavity will be plugged with gauze, and the plug gradually raised—in the manner which we have repeatedly recommended—and the bleeding points secured one after the other as they come into view.

When every bleeding vessel has been caught and tied, it is always advisable before terminating the operation to relax the compression or remove the band, as the case may be, to make sure that all the vascular channels are secured.

The great secondary danger in these cases is **gangrene,** and, as is well known, **an associated injury of the great vein** on the one hand, and the necessity for excluding **a fairly long segment of the artery** from the circulation on the other, are very important factors in the causation of these gangrenes.

If the vein is ruptured, its two ends must also be tied, but care will

be taken to place the ligatures on the ends of the vein, still more particularly when dealing with the artery, just far enough from the rupture to be secure and so to spare the collaterals as far as possible.

Another element of capital importance is asepsis in these huge wounds. There can be no doubt that infection is one of the principal causes of the dangerous secondary hæmorrhages and gangrene.

WOUNDS AND RUPTURES OF TENDONS.

Every divided tendon ought to be sutured at once: this is a very simple rule, and so evidently true that it seems almost superfluous to repeat it.

But daily observation shows that the repetition is not unnecessary; not only are wounds of tendons not always sutured forthwith, but they are sometimes overlooked. I could mention cases in which the persisting functional disability had alone called attention to the solution of continuity of the tendon at the end of some days, or even after the lapse of several weeks.

It is the wrist, the hand, and the fingers which are most frequently affected by these injuries, and at the front of the wrist a wound, by a splinter of glass for instance, may involve at the same time the *ulnar artery and nerve, the median nerve, the radial artery*, and *the flexor tendons*. In the foot (*Fig.* 493), in many regions, indeed, a similar accident may occur; hence the necessity for always being in possession of certain anatomical knowledge.

In recent wounds, at least in the case of incised wounds, and when the tendon has not sustained any loss of substance, the task is comparatively easy; the exposure of the two ends is generally a simple matter, accurate approximation can be effected, and direct reunion is possible.

Begin by disinfecting the wound and the surrounding region with great care. If the two ends of the divided tendon are visible between the edges of the cutaneous wound, no preliminary manipulations will be necessary.

More often, however, the upper end is too far retracted to be seen at once. Let us presume that we have to do with a wound on the anterior aspect of the wrist.

Apply an elastic bandage or an ordinary bandage to the forearm from above downwards, from the elbow to within an inch from the wound; in this way the muscles are compressed and forced downwards, and almost always the sought-for end appears in the wound. The same object may be achieved by **muscular expression** (Le Fort), the fleshy mass of the forearm being grasped by the hands of an assistant and pressed down towards the wrist (*Fig.* 494).

If this manœuvre proves insufficient—which will seldom happen in recent injuries—do not begin to grope about by chance within the tendon

sheath with hooks or forceps or retractors for the invisible end ; incise the wound freely in the proper anatomical direction. For the sake of the future, it is advisable to make the skin incision, not directly over the sheath, but a little to one side. The tendon will then be exposed by retracting the edge of the incision towards the appropriate side, or again, a small flap may be cut ; in this way, the line of suture in the sheath and

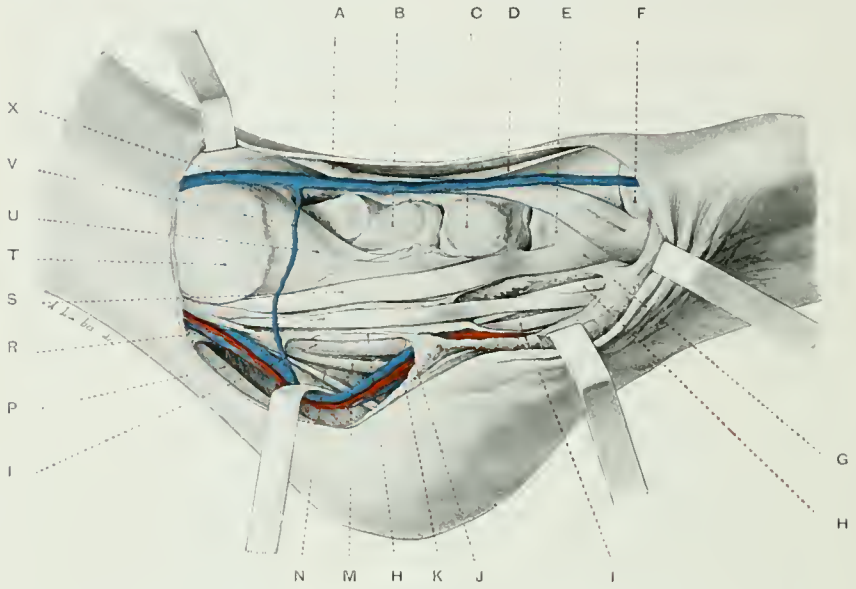


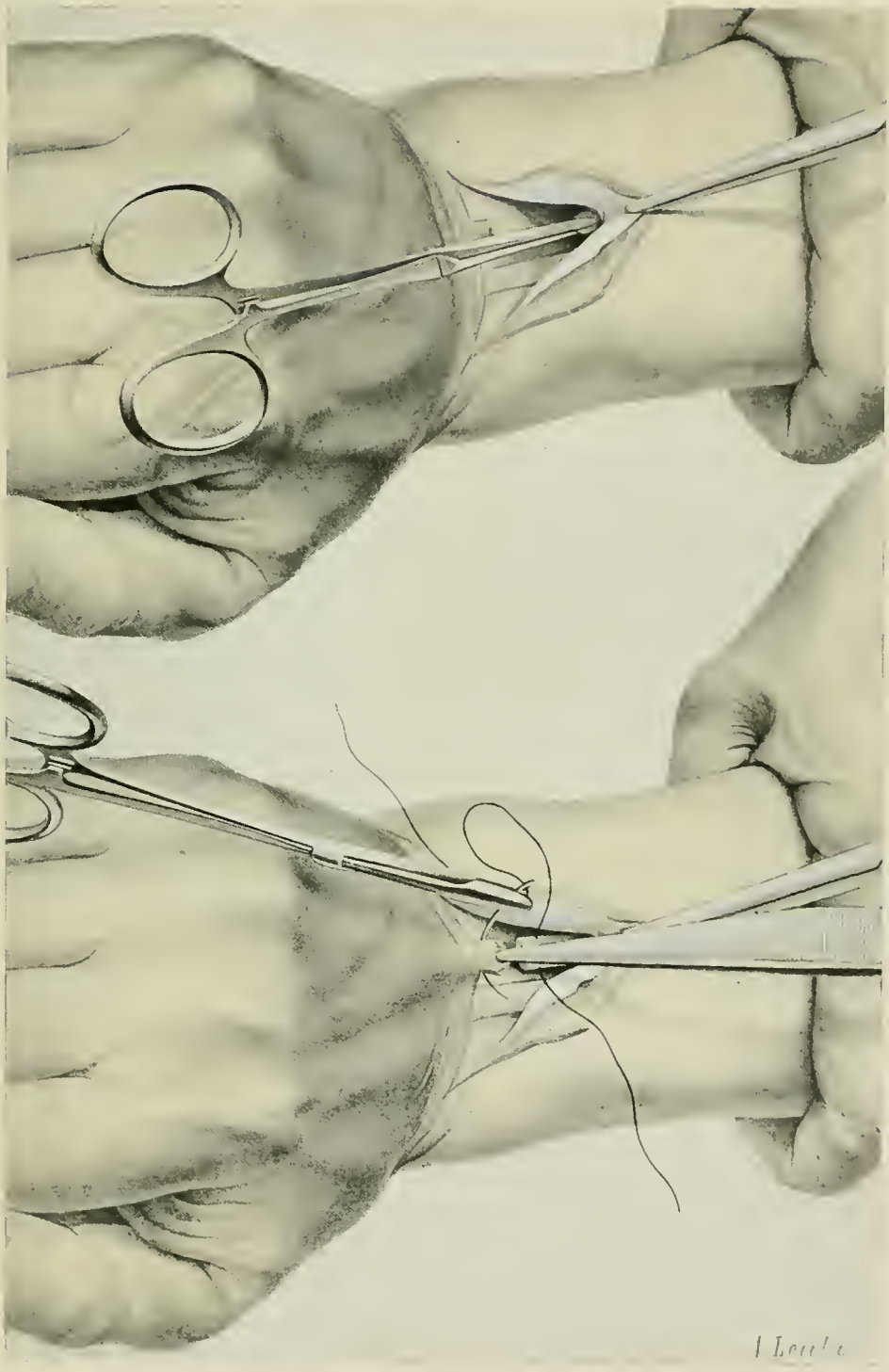
Fig. 493.—Inner side of the foot. (A) Tendon of the tibialis anticus. (B) Head of the astragalus. (C) Scaphoid. (D) Tendon of the extensor longus hallucis. (E) Internal cuneiform bone. (F) Base of the first metatarsal. (G) Prolongation of the tendon of the tibialis posticus, inserted into the internal cuneiform. (HH) Tendon of the flexor longus hallucis. (II) Internal plantar nerve. (J) Posterior tibial vessels at their point of division. (K) Plantar fascia. (M) External plantar nerve. (N) Calcaneal branch. (P) Tendo Achillis. (R) Tendons of flexor longus digitorum. (S) Tendon of tibialis posticus. (T) Internal malleolus. (U) The internal lateral ligament of the ankle joint. (V) An anastomotic venule joining the internal dorsal vein with the posterior tibial vein. (x) The internal dorsal vein of the foot (origin of the internal saphenous vein).

the line of skin suture will not be exactly superimposed, and fusion of cicatrices and the always troublesome adhesions will be avoided.

The upper end is found ; draw it down with forceps or by a thread passed at once through its thickness, and see if it comes in contact with the lower end, which again is approximated by flexing or extending the fingers, etc.

1. **The two ends have been found and brought together.** The next step is to suture them ; but before doing so, be careful to distinguish the corresponding ends when several tendons are divided, and make sure that none are still wanting (*Fig.* 494).

Plate X.—**Suture of Tendon.**—In the upper figure the muscle end of the tendon is exposed, after longitudinal incision of the sheath, and secured with forceps. In the lower figure is shown the first step in the suturing : the supporting suture.



SUTURE OF TENDON

Suture.—The object in view is to restore mechanically—and strongly—the continuity of the tendon; exact adjustment is a necessary factor for obtaining a perfect result. The more regular the form of the tendon after suturing, the better will it recover its easy mobility and normal function.

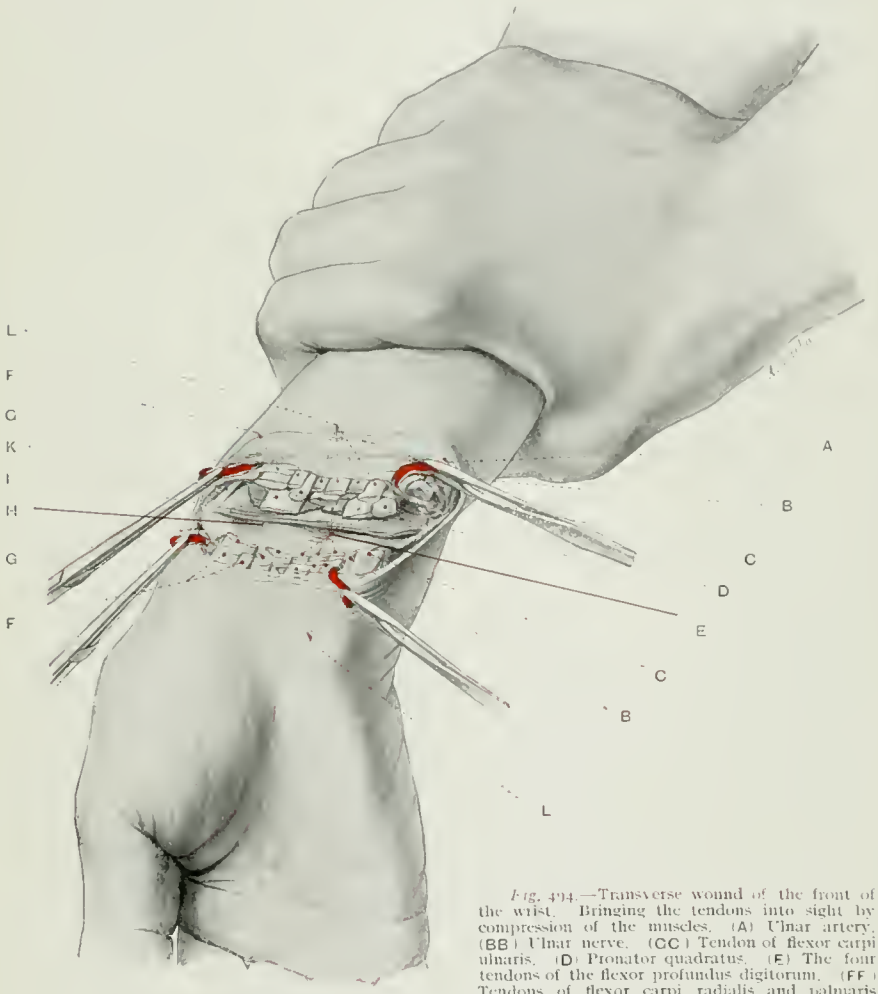


Fig. 404.—Transverse wound of the front of the wrist. Bringing the tendons into sight by compression of the muscles. (A) Ulnar artery. (BB) Ulnar nerve. (CC) Tendon of flexor carpi ulnaris. (D) Pronator quadratus. (E) The four tendons of the flexor profundus digitorum. (FF) Tendons of flexor carpi radialis and palmaris longus. (GG) Radial artery and anterior branch of the radial nerve. (H) Median nerve. (I) Flexor longus pollicis. (K) Insertion of supinator longus. (LL) The four tendons of the flexor sublimis digitorum

Use fine silk, properly sterilized—catgut will do for small tendons—silkworm gut is also perfectly serviceable. The sutures are passed with a fine, perfectly smooth needle, an ordinary suture needle, a Hagedorn needle, a simple sewing needle, or a small Reverdin needle. If the tendon has been clean cut, any freshening of the ends is quite unnecessary; be content

with carefully wiping and cleansing the two surfaces before adjusting them. If the ends are torn and dirty, trim them very sparingly with a sharp, transverse cut of the knife or scissors.

Let us consider first of all the method of dealing with *a fairly large, cylindrical tendon*. The best plan is this: Introduce first of all **a supporting suture**, which is knotted at the side of the tendon; it is passed through one of the ends, at about a third of an inch from the plane of section and through the entire thickness of the tendon, from left to right for example; it is then passed back, from right to left, through the other end, at a corresponding distance from the line of division; this suture is tied at once, and sufficiently tight to bring the two cut surfaces in close contact, or even to evert them a little. Then complete the union by **one or two adjusting sutures.** These are passed longitudinally, traversing the upper end from before backwards, the lower end from behind forwards, and are knotted on the anterior surface (*Fig.* 495). In this manner, with due care, perfect continuity can be obtained, and I shall therefore simply content myself with illustrating another more elaborate procedure, that of Trnka (*Figs.* 496, 497, 498, 499), which may be useful in dealing with very large tendons, and also in cases of ruptures, which we shall consider farther on.

Fig. 495. Tendinous suture: supporting suture and adjusting sutures. (M. Le Dentu's method.)

In uniting, *a flat, comparatively thin tendon*, one may simply pass two or three sutures longitudinally from one end to the other, and tie them very gently and steadily; but in spite of all the care which may be exercised, these longitudinal sutures, *parallel to the tendinous fibres*, have always a great tendency to split the end of the tendon, and cut out before the ends can be placed in good contact.

It is always better to pass the suture **transversely**; and notwithstanding the comparative thinness of the tendinous band, this supporting loop can always be quite satisfactorily introduced by Le Fort's or Wölfler's methods, which are sufficiently explained by *Figs.* 500 and 501. With *a slender tendon*, Tillaux's suture will be found very useful: a single thread is passed obliquely through the two ends (*Fig.* 502) and is knotted at the side; it ensures good contact and firm union.

If the tendon is too small or too much frayed out for satisfactory suture to be possible, it will be well to have recourse to Schwartz's method: each end is encircled at about a quarter of an inch from the cut margin with a ligature, then two longitudinal sutures are passed through the ends above and below the ligatures, which serve as points of support (*Fig.* 503).

After the tendon has been reunited and the ends of the sutures cut short, great care must be exercised to **restore the wall of the sheath,**

by means of a continuous suture of fine catgut, or if the sheath is to a large extent destroyed, at least to construct a continuous envelope around the

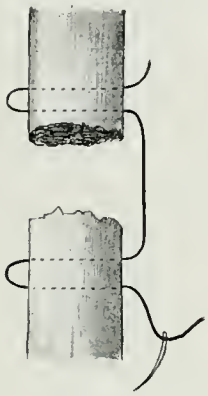


Fig. 496.

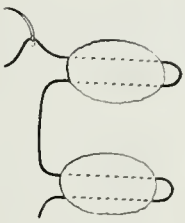


Fig. 497.

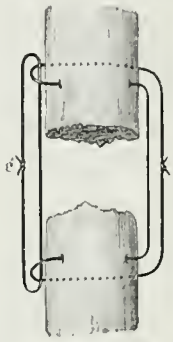


Fig. 498.

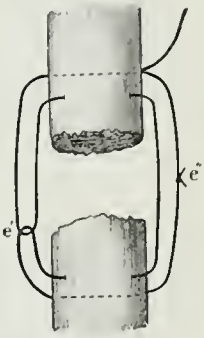


Fig. 499.

Fig. 496.—Tendinous suture, Trnka's method. 1st step: The thread is passed twice through the thickness of each end.

Fig. 497.—Idem. The two ends of the tendon in transverse section; shows the double course of the thread.

Fig. 498.—Tendinous suture, Trnka's method. 2nd step: A lateral loop at one side of the tendon connects the thread, which has been twice passed through each end.

Fig 499.—Tendinous suture, Trnka's method, with a single thread.

Fig. 500.
Tendinous suture.
(Le Fort's method.)

Fig. 501.
Tendinous suture.
(Wölfler's method.)

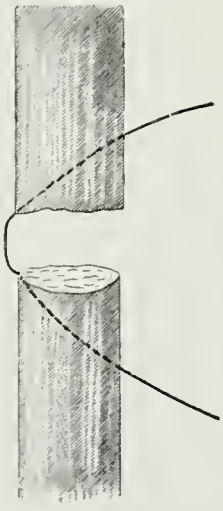


Fig. 502.
Tendinous suture.
(Tillaux's method.)

Fig. 503
Tendinous suture.
Schwartz's method.)

tendon, a tunnel in which it can move and *which isolates it from the cutaneous cicatrix*, by suturing the neighbouring fibrous tissues over it. The skin is

then sutured, and the limb fixed in the position which gives the least tension upon the repaired tendon.

But it is necessary to consider some more difficult conditions, and to be acquainted with the methods of dealing with them.

2. **The two ends have been found, but it is impossible to bring them together.**—It may be that the tendon has suffered a more or less extensive loss of substance, and though the two ends have been found, they cannot be placed in contact.

Fig. 504.

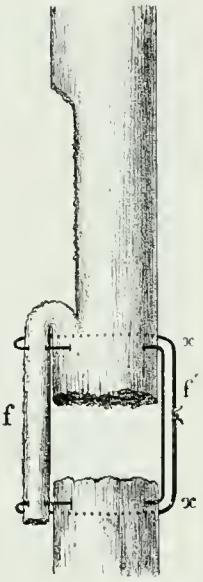


Fig. 505.

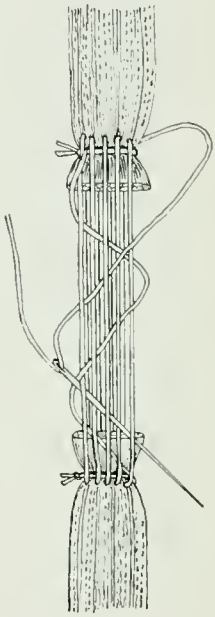


Fig. 506.

Fig. 504.—Elongation of the tendo Achillis by "accordion incisions." (A. Poncet, Thèse de Pécheux.)

Fig. 505.—Distant tendinous suture. (Trnka's method.) (*f*) Strip of tendon turned down. (*ff*) Double loop suture, traversing both ends of the tendon and fixing the turned-down strip. (*f'*) The suture knotted on the opposite side.

Fig. 506.—Distant tendinous suture by means of catgut loops.

What is to be done then? Notwithstanding the forced position of the limb, in spite of traction on the upper end, coaptation remains impossible, or contact is only obtained by means of so abnormal a position of the limb as in itself to constitute an infirmity.

If the tendon is of considerable size, thick and broad, it may be **lengthened** by the "**accordion incisions**" recommended by M. Poncet; the method is sufficiently explained by *Fig.* 504.

Usually, however, the only available plans are **the distant suture** and the **suture by anastomosis.** Tendon grafting—the interposition of a

segment of tendon obtained from a dog or rabbit between the separated ends—is impracticable in urgent cases, and besides, with a few exceptions, the results which it has so far given have not been very encouraging.

Distant suture may be performed in two ways: (1) By introducing a series of loops of silkworm gut or catgut, between the two ends; these loops serve to fill up the gap, and at the same time as guides for the healing processes which ultimately repair the deficiency; (2) By lengthening one of the ends.

The first plan is the more certain. Between the two ends, four, five, or six loops of catgut or silkworm gut are placed, each loop being passed through the tendon at about a quarter of an inch from the cut surfaces, and care is taken to interweave the portions of the various loops; or again, a ligature may be placed around each of the ends and the loops passed through the tendon beyond the ligatures in the manner already

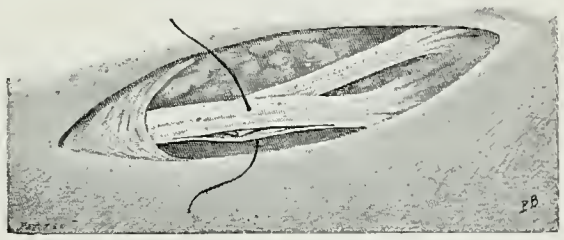


Fig. 507.—Suture by anastomosis. (Tillaux and Duplay's method.)

described, and in sufficient number to form an adequate bridge between the two segments (*Fig.* 506).

As to the method by splitting one of the ends, it is very ingenious, but in practice it gives only very doubtful security. The two strips of the lengthened tendon have a very decided tendency to separate completely, and the one which is turned down often becomes detached altogether; it then becomes necessary to suture it at both ends, like an actual graft, and the ultimate result is always very uncertain.

Trnka's method, shown in *Fig.* 505, which combines lengthening with distant suture, is, in my opinion, much to be preferred.

If the gap is considerable, and if the conditions are not favourable for introducing a good distant suture, it is much better at once to **anastomose the peripheral end to a neighbouring tendon**, acting in the same direction and of analogous function, in the manner to be described immediately. As to the muscular end, if it is accessible it also should be united to the nearest tendon, the action of which it will at least serve to reinforce.

3. **The peripheral end alone is found.**—The method of suture by **anastomosis** must be employed when the peripheral end alone can be

found. I have already said that the anastomosis must be made with the nearest tendon of similar function.

The technique is as follows: (*a*) A small longitudinal slit is made in the "receiving" tendon, and the lower end, freshened if necessary, is inserted into the slit and fixed by one or two sutures (*Fig.* 507); (*b*) By means of a knife slipped on the flat through the "receiving" tendon, it is

Fig. 508.—Suture by anastomosis. (Schwartz's method.)

split longitudinally into two portions, superficial and deep. The superficial slip is separated altogether from its insertion, and is alone placed in contact with and sutured to the peripheral end (*Fig.* 508). Although these methods are chiefly applicable to old-standing cases, it is well to be acquainted with them, because the knowledge will in certain cases enable the operator to choose the treatment which is most suited to the conditions.

Subcutaneous Ruptures of Tendons.

In **subcutaneous tendinous ruptures**, the treatment must be governed by the same principles, and **immediate "open" reunion** represents the most rational and the surest method. In default of operation, or if it is impossible in view of important contra-indications, **massage**, begun at once and continued for some months, will give the best results; here, even more than in cases of fracture of the olecranon or patella, the results to be obtained by massage are immeasurably superior to those given by immobilization and all the various mechanical methods of approximating the ends of the ruptured tendon. All these methods are illusory, and assure no real coaptation, and they are harmful owing to the stiffness and rigidity which their use inevitably entails.

The patient's best interests will be considered by exposing the two ends of the ruptured tendons at once and suturing them. Of course, all necessary precautions will be taken for the preservation of asepsis, and the whole region will therefore be thoroughly and widely prepared. The incision must always be sufficiently long to enable the operator easily: (*a*) **To evacuate the effused blood and thoroughly to cleanse the space between the two fragments**; and (*b*) **To find, adjust, and firmly reunite the two ends.**

The technique of the reunion is identical with that which we have just discussed: a **supporting suture** and **two or three adjusting sutures** will usually be required.

In dealing with *a very large tendon*—the quadriceps tendon, the tendo Achillis, or the tendon of the triceps, for instance—it will be necessary to modify the type of suture somewhat for the purpose of obtaining all the strength possible. I have obtained very excellent results in a case of *rupture of the quadriceps tendon* by the following method :—

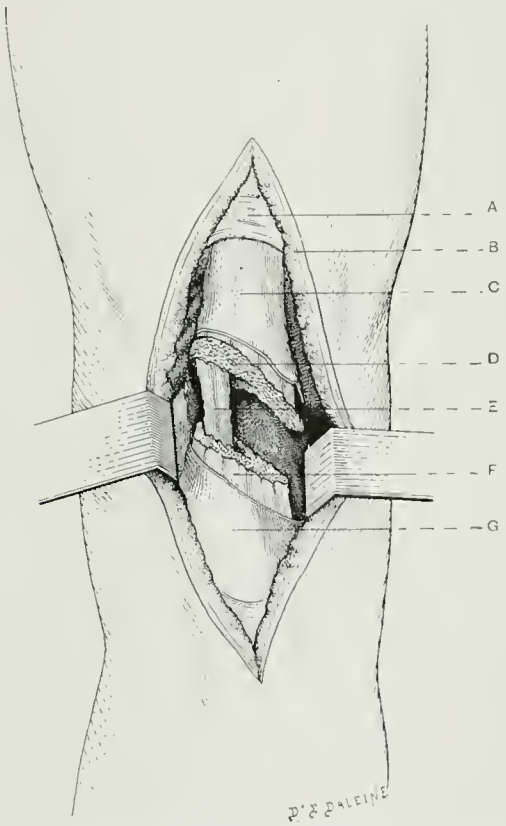


Fig. 509.—Subcutaneous rupture of the quadriceps tendon. The rupture exposed: 1st step in the operation. (A) The retracted margins of the fascial covering of the tendon. (B) Subcutaneous fat. (C) Upper end of the tendon. (D) The ruptured surface of the upper end. (E) An unruptured strip at the posterior surface of the tendon. (F) Lower end. (G) Patella.

Case 35.—The patient was a very powerful man, some 50 years of age, and very stout; the accident had been caused by a false step during a forced effort to save himself from falling. The loss of power was complete; the supra-patellar region was occupied for a height of about four inches by a diffuse swelling, under which a deep transverse groove could be felt quite definitely and evidently corresponding to the lower part of the quadriceps.

I made a free incision along the anterior surface of the thigh, and under the aponeurosis I opened into a cavity filled with clots and liquid blood, at the bottom of which I at once perceived the lower end of the

tendon, and then, three inches higher up, the upper end (*Fig.* 509); the line of rupture ran rather obliquely, and the surfaces were somewhat irregular. Below, the supra-patellar articular pouch was torn, but only to a limited extent, and practically no blood had penetrated into the joint. After very careful cleansing of the whole focus and closing the capsular laceration by a few catgut sutures, I proceeded to repair the tendon. I first passed a strong silk suture through each of the two ends at about a third of an inch from the margin of the rupture; the thread was passed transversely in and out through the thickness of the two segments of the tendon as represented in figure 510. That being done, I made sure that the two ends could be brought together, and before knotting the supporting suture

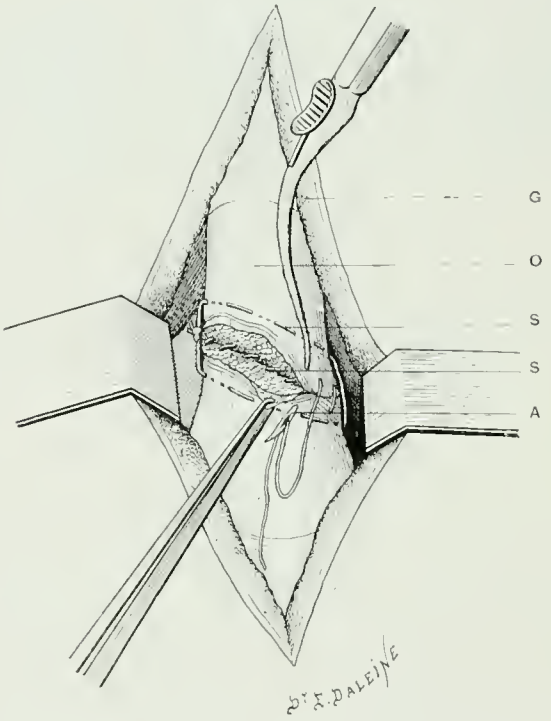


Fig. 510.—Reunion of the ruptured quadriceps tendon in three layers. (G) Subcutaneous fat. (O) Upper end of the tendon. (S) Transverse supporting suture passed in and out in the thickness of each of the two ends. (S') Continuous suture uniting the posterior margins of the rupture. (A) Continuous suture uniting the anterior edges of the rupture.

at the side of the ruptured tendon, I united the posterior borders of the rupture by means of a continuous suture of finer silk—that was the *first plane of suture.*

Then, *second plane*, I tied the supporting suture. Lastly, I completed the reunion by a second continuous suture which adjusted the anterior margins of the rupture. In this way I had *three layers of sutures.*

The aponeurosis covering the tendon was sutured and the skin wound closed. The tendon was perfectly restored, and the functional results were excellent.[1] The general principle of the method seems to me to be well worthy of recommendation in dealing with the large tendons.

[1] *Soc. de chir.*, 11 avril, 1899.

Poirier also used a method of suturing in layers in one case where the rupture of the fibrous planes of the quadriceps tendon had occurred at different levels and had resulted in a very interesting condition of affairs. After having opened up the focus of rupture he recognized very definitely : (1) That the superficial layer (the tendon of the rectus) was ruptured transversely about a fifth of an inch above the base of the patella ; its upper end had retracted to a distance of 2 in. ; (2) The middle layer (the intercrossing fibres uniting the tendons of the two vasti muscles above the patella) was ruptured vertically, causing a separation of the vasti, the inner tendinous borders of which formed two vertical bands, the external being the larger ; (3) The deep layer (the tendinous lamina of the crureus) was ruptured 3 in. above the patella ; its lower border, attached to the patella, was turned downwards in front of the bone, between it and the skin. On examining the deep surface of the tendon of the rectus, the gap left by the tearing away of tendinous lamina of the crureus could be quite

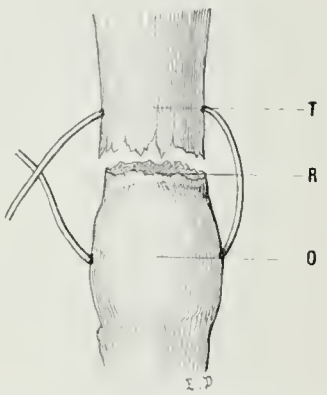


Fig. 511. — Reunion of the tendon of the triceps, ruptured quite close to the olecranon. Osteo-tendinous suture. (T) The ruptured tendon. (R) Stump of tendon, too short to be sutured directly. (O) Olecranon.

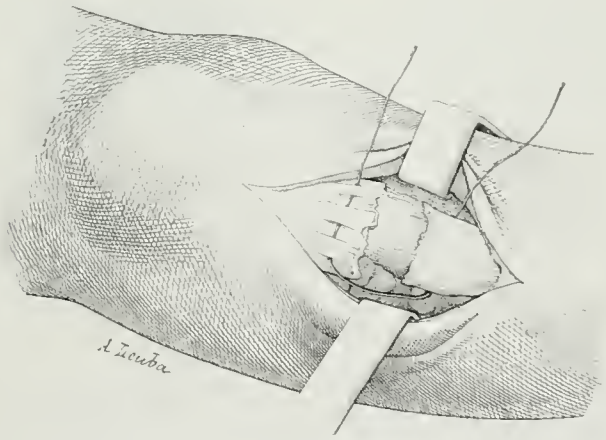


Fig. 512. — Rupture of the patellar ligament. Reunion by a transverse suture passing through the upper end of the ligament and the anterior tuberosity of the tibia.

plainly seen, above the intercrossing of the vasti fibres. M. Poirier reunited the three planes of the tendon separately, and commenced massage on the fourth day. By the twenty-second day the patient

could walk well without support, and flex the knee to a right angle.[1]

The technique must be modified in certain conditions according to the situation and characters of the rupture.

1. **The tendon is ruptured quite close to its insertion** ; it is, in fact, torn away from its attachment.

In such circumstances the stump of the tendon is too small to furnish adequate support for the sutures ; the difficulty can be very satisfactorily overcome by passing the lower portion of the **suture through the bone,** the patella, the olecranon, or the calcaneum as the case may be.

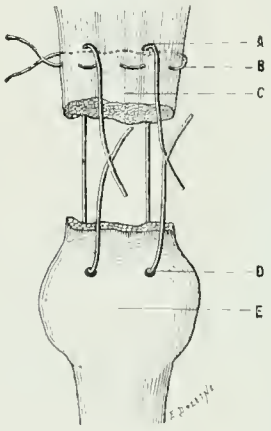


Fig. 513. — Distant suture of a ruptured quadriceps tendon by Lucas-Championnière's method. (B) Loop of silver wire worked in and out in the upper end. (A) Longitudinal loops passing above the supporting silver wire and below through the patella. (C) End of the ruptured tendon. (D) Holes bored in the base of the patella. (E) Patella.

A silk or silver wire suture is passed transversely on the one hand through the thickness of the tendon, $\frac{1}{2}$ in. at least from the line of rupture, and on the other through the bone, as shown in *Figs.* 511 and 512[2] ; the suture is tightened and secured, and once contact between the two segments is thus obtained, the margins will be adjusted by a continuous suture.

2. **The separation is too large for the two ends to be brought together.**—In these conditions the ingenious method of distant suture recommended by M. Lucas-Championnière[3] should be adopted.

A double silver thread is passed transversely in and out through the thickness of the upper end, and serves as a support for the sutures (*Fig.* 513) ; two or three longitudinal loops are passed through the tendon above the supporting wire, and also through the patella or olecranon, etc. The gap is thus filled up by a metallic band, around which, if the patient is still young, fibrous tissue will develop and regenerate the tendon.

In case of rupture in the body of the tendon, and when the lower end remains sufficiently long, transverse supporting wires will be placed in each of the ends and the longitudinal loops passed between them.

Practically, however, in recent ruptures it will very seldom be necessary to have recourse to these valuable devices.

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[1] (Poirier, *Soc. de chir.*, 17 mai, 1899, p. 542.)

[2] This is the method of osteo-tendinous suture, recommended by MM. Quénu and Duval for the treatment of ruptures of the quadriceps close to the patella. ("Traitement opératoire des ruptures sus-rotuliennes du quadriceps," *Revue de chir.*, 1905, t. i., p. 169.)

[3] Lucas-Championnière, "Réparation d'un muscle par des fils métalliques." *Gaz. des hôp.*, 1898, p. 400.

WOUNDS OF NERVES.

Immediate suture is here quite as necessary as in the case of a divided tendon : not because one expects to obtain that immediate restoration of function which, in spite of some recorded instances, is still hypothetical, but for the very positive scientific reason that *exact and permanent adjustment of the two ends of a divided nerve is the best means of insuring regeneration and of shortening the duration of the period of lost function.*

In suturing a divided nerve, the essential point is to secure even and firm contact, and at the same time, by asepsis of the wound and careful isolation of the nerve, to prevent the inflammatory complications, the

Fig. 514. Nerve suture. — Oblique freshening of the two ends.

Fig. 515. Nerve suture. Wedge-shaped freshening of the two ends (Bruns).

adhesions, and the compressions by scar tissue, which interfere with the natural healing processes.

Apart from the cases where there is loss of substance (see later), the two ends are as a rule easily found.

From the statements which have just been made with regard to the physiological regeneration of nerves and the conditions necessary for successful suturing, it naturally follows that mere suture of the neurilemma must be absolutely given up ; sutures passed through the sheath alone will give only imperfect coaptation and doubtful security. **The needle must be passed boldly through the centre of the nerve** ; the passage of an aseptic needle or the presence of an aseptic suture has never caused neuritis.

If the two ends are lacerated, contused, or frayed-out, they must be freshened by excising the extremities as sparingly as possible. **Oblique**

freshening (*Fig.* 514) is to be preferred when applicable, as it gives broader surfaces to be brought in contact. **Wedge-shaped freshening** (*Fig.* 515) will sometimes be useful, though less commonly than in old-standing cases.

During these preliminaries, and in all the rest of the manipulations, be careful to handle the nerve very delicately, grasping it by the sheath with fine dissecting forceps, without bruising or tearing it. These instructions apply particularly to the upper end, *the regenerating end*, the integrity of which it is important to respect. The best materials for executing the suture are fine silk or catgut, and a fine, round needle which separates the nerve fibrils without cutting them, or a Hagedorn needle passed with

Fig. 516.—Simple suture (Nélaton's method.)

Fig. 517.—Supporting suture (P) and adjusting sutures (SS). (Mickulicz' method.)

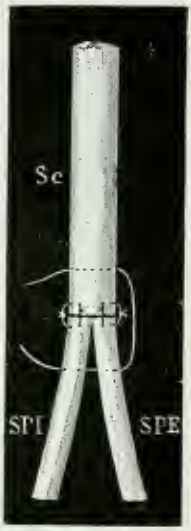

Fig. 518.—Suture of the sciatic and its two branches after division in the popliteal space. Transverse supporting suture; adjusting sutures.

its flat surfaces parallel to the borders of the nerve. Of course they are by no means indispensable; with due care a good nerve suture can be effected—in an emergency—with any available thread, properly boiled, and an ordinary sewing needle.

A single suture may suffice if the nerve is small (*Fig.* 516). Still, here again, even though the nerve is small, it is always a good practice to employ **a supporting suture** and **two adjusting sutures.** The supporting suture passes through each of the ends from behind forwards, at about a third of an inch or more from the cut surfaces, and is knotted in front. The adjusting sutures are introduced close to the ends, and are passed through the outer layers only of the nerve (*Fig.* 517). If the nerve trunk is large, two supporting loops and three adjusting sutures may be employed with advantage.

But in the last conditions it will often be better to introduce the supporting suture **transversely**, in the manner already recommended for suturing a tendon.

This method will be particularly useful when the section has affected a nerve trunk at a point of division, and when consequently there are three ends to be reunited. In one case, in which the sciatic nerve had been cut at its termination where it divided into the internal and external popliteal nerves, we used it with satisfaction (*Fig.* 518).

The ends of the sutures are cut short; then an effort must be made, by means of a continuous suture of fine catgut, **to reconstruct an isolating fibrous sheath** around the reunited nerve, to protect it as far as possible from subsequent cicatricial constriction. It is always desirable, if the site and characters of the wound permit, to avoid placing the line of the cutaneous cicatrix directly over the sutured nerve.

Lastly, the **limb will be immobilized** in the position best adapted for the avoidance of traction on the ends of the nerve.

The operation is in fact a comparatively simple matter. It only becomes difficult—in recent cases—**when a fairly extensive loss of substance interferes with the approximation of the two ends**, or again, when they have been so much damaged that the necessary freshening results in a corresponding deficiency.

What is to be done then? **Stretching the central end**, by grasping it between the fingers and pulling steadily and slowly, may be of some service, and may suffice in cases where the separation is not great. If this method is inadequate, the only other resource—in urgent practice—consists in **distant suture**. Two or three loops of silk or catgut are placed between the two ends to serve as guides for the regenerating nerve fibres.

If a decalcified bone tube is at hand, it may be used to ensheath the ends of the nerve and the connecting sutures, and may prove of great value. An attempt should also be made to achieve the same object by forming in the best way possible an isolating connective tissue sheath around the nerve and the sutures.

As to the other methods—nerve-splitting, nerve-transplantation, etc.—they are hardly applicable in urgent surgery, and besides, the results do not appear to be any better than those obtained by the simple distant suture which we have just described.

WOUNDS OF JOINTS.

We have already considered compound fractures involving joints, and discussed the urgent indications which arise from these grave injuries; here we shall devote our attention to: (1) *Wounds of joints* (punctures, incised wounds, contused wounds) *without lesions of the articular extremities of the bones*; (2) *Gunshot wounds of joints.*

1. **Punctured Wounds.**—If the lesion is a **simple puncture** (a stab with a stiletto, a bodkin, a rapier, a foil, a bayonet, etc.), **small, clean, and recent,** the best plan will be to wash and carefully disinfect the whole region, envelop it with sterile compresses, and to fix the joint at once—not with the traditional wire gutter-splint, which exercises but little control, but with a large, well-padded dressing reinforced with a broad posterior splint, or, better still, by means of a plaster apparatus; and lastly, **to watch the temperature.**

If there is no rise of temperature, no thermal reaction during the three or four immediately succeeding days, the danger will be over, and the intra-articular effusion which almost invariably appears is harmless; it will be absorbed under compression, but if great it may be aspirated with advantage.

It is a very different matter when, in the evening or the day after the accident, the temperature rises, the joint becomes rapidly swollen, and the articular pain increases steadily; or again—another eventuality not uncommon in practice—when the surgeon is not called in until some days after the receipt of the injury, which has been altogether neglected, and **undoubted signs of commencing infection** are found, such as fever, effusion, acute and increasing pain, or diffuse redness of the skin around the site of the wound and extending in streaks up the limb. In such conditions, there can be no excuse for hesitation; it was justifiable at the time of the accident, and in view of the nature of the wound, to take the chances—on the whole very good—of the absence of inoculation, or at any rate of very mild and easily checked infection; but as soon as the first signs of infection render themselves evident, immediate action is necessary, and any half-measures, any delay, will be attended with serious dangers, and will entail grave responsibility. **Arthrotomy must be performed, and the articular cavity cleansed and drained.** (See *p.* 545).

When efficiently performed and sufficiently early, this treatment will cut short the developing infection and its terrible consequences; and further, it is also the best means of safeguarding the functions of the joint. Once the temperature has come down and the threatening symptoms have subsided, the drainage tube will be taken out, and as soon as possible, by the tenth day or so, the splint, which no longer fulfils any useful purpose, will be removed.

In other cases the situation is even more alarming; it is no longer commencing infection which has to be dealt with, but undoubted, **well-established infection, a suppurative arthritis or something very near to it.** The temperature is high and oscillates widely, the joint is swollen, red, and œdematous, the pulse is fast and small, the tongue dry, the general condition already alarming.

Open up the joint as widely as possible, leave it open, and provide the freest possible drainage. And do it immediately, if it is hoped to save the patient and the limb, and to check the fatal evolution of the suppurative arthritis.

There is, unfortunately, no lack of examples to demonstrate the urgent

necessity for these measures. I remember the case of an unfortunate man, some fifty years of age, in whom an ill-cared-for punctured wound of the left knee-joint had been the starting-point of a suppurative arthritis, which was treated at first inadequately by a short incision and insufficient drainage; within a very few days the local and general symptoms had made most alarming progress. The knee was opened widely on both sides of the patella, and repeatedly and freely irrigated, without any benefit; as a last resource, amputation through the thigh was done, but it was too late; the patient succumbed next day.

Remember, therefore, the dangers of suppurative arthritis and the septicæmia which so speedily follows, and without wasting time in aspirating or making button-hole incisions, at once lay the joint cavity as widely open as possible.

Open Wounds. What we have just said is applicable *to all wounds of joints, other than punctures.* And first, **what is to be done with a fresh articular wound?**

To-day the correct treatment is perfectly definite, and permits of no exceptions; the indications are identical with those which we have already enunciated with reference to wounds of the abdomen.

Every articular wound must be forthwith enlarged sufficiently to provide free access to the joint cavity; the joint will be washed out with warm salt solution, then carefully cleansed and dried out with sterile gauze. If the wound is quite recent, not lacerated and not dirty, after this irrigation and careful cleansing, it may be closed completely without drainage, the capsule and skin being sutured separately, and of course the joint will be immobilized at once.

But even in such apparently favourable circumstances, it is usually advisable to place a small drainage tube at the lower angle of the wound; if no complications ensue, it will be removed after forty-eight hours. When the wound is contaminated with earth, fragments of garments, etc., the cleansing must be even more thorough, if that is possible, and if it seems necessary there should be no hesitation in making a complementary incision; lastly, drainage is imperative.

In the case of a **dirty, inadequately treated wound,** or an **infected and already suppurating joint,** simple enlargement of the original wound is insufficient; **free arthrotomy, with counter-openings** for drainage, is indispensable. Often even this treatment is inadequate, and to ensure good drainage of the whole cavity, immediate resection may be required. M. Poncet[1] has emphasized the value of **early resection** in cases of infective traumatic arthritis; in these grave conditions it constitutes the only means of saving the limb, but to be of any value it must be undertaken without delay.

[1] Poncet et Lagoutte, *Gaz. hebd.*, 1893, also Th. de Mailhetard, *De la résection du genou comme traitement des arthrites infectieuses par plaies pénétrantes de cette articulation.* Lyon, 1899.

2. **Gunshot Wounds.**—I now come to gunshot wounds, to those, at least, which we have occasion to treat in civil practice.

They are usually caused by small shot, or revolver bullets, more rarely by projectiles of larger calibre, sometimes even by bullets fired from military rifles.

Wounds inflicted with smooth-bore guns are not uncommon; their frequency is indeed sufficiently great to entitle them to close consideration—here I shall discuss them in so far as they affect the articular regions. The lesions observed are of variable gravity. It may be that only **a few pellets have entered the joint,** owing to the shot having been fired at a distance, or to the deviation or deflection of part of the charge. In such circumstances no active treatment is indicated in the first instance. If present at the accident, do not forget that the first precaution to be taken is to immobilize the wounded joint; a temporary fixation apparatus will be improvised (see FRACTURES), and the patient will be gently transported to the nearest suitable place. There the whole region will be carefully washed and disinfected in the manner already described, and the final immobilization apparatus will be applied.

Nothing more should be done at first; and if the treatment has been properly carried out, the accident will rarely give rise to any trouble, and uncomplicated healing will take place. A rise of temperature, pain, and rapidly increasing effusion into the joint during the days succeeding the accident will constitute an indication for arthrotomy.

The situation is quite different when **the shot has been fired from quite close at hand and perhaps the whole charge has penetrated the joint.**

At the scene of accident, the treatment is the same as before; make no exploration of the wound, but simply envelop the injured region in a suitable dressing, immobilize the limb, and have the patient transported.

As a rule, the joint swells very quickly. Sometimes, when the distance has been too short to allow the shot to spread, there may be only one or several torn, blackish wounds, from which blood is escaping. Make all the necessary preparations for opening, washing out, and draining the joint, have the patient anæsthetized, and forthwith, without waiting for further information, without waiting for the development of symptoms, open up the articulation. In the joint-cavity, blood, shot, and often fragments of bone or cartilage will be found, and will be removed by free irrigation with boiled salt solution. It is unusual to meet with extensive destruction of the ends of the bones.

A revolver bullet produces very similar but more marked lesions. The hæmarthrosis, more or less abundant, is an indication, not only of the injury to the soft tissues, but also of the bony lesions (detachment of splinters, fissures, etc.). The bullet may, however, traverse the joint from side to side (at least some joints and in certain attitudes) without causing great damage; or again, it may implicate only the periphery of the articulation, and become embedded in one of the epiphyses.

If, therefore, the local reactions are very mild, if there is no fever and

no great swelling, then simple immobilization, as already recommended, will be sufficient.

When there is a **large hæmarthrosis** it is as a rule better to **open up the joint at once**, in order to empty and cleanse the cavity. Sometimes, though rarely, one may be fortunate enough to encounter the bullet and to be able to extract it ; this happened in one of our own cases.

Case 36.—The patient had received a revolver bullet in the left knee ; the wound of entry was situated just above the patella in the mid-line of the limb, and the joint was distended with blood. I performed arthrotomy along the outer border of the patella and evacuated a large quantity of thick, dark blood, and while exploring the cavity of the joint I found the bullet lying free over the internal condyle. It was extracted, the joint cavity irrigated with salt solution, and the wound was closed, a small drainage tube being left at the lower angle. Recovery took place without any complication.

In case of injuries inflicted with **projectiles fired from military rifles** or with **large bullets fired from a close range**, or as the result of **explosions**, the bony lesions are often very serious, and the question of **resection**—typical or atypical—may arise. The treatment should be conducted on the lines already laid down with regard to fractures involving joints. An effort should be made to trim the damaged bones, reserving any more extensive resection till later, if it should become necessary. Lastly, primary amputation should only be performed in very exceptional circumstances. (See Crushes.)

PUNCTURE OF THE KNEE AND URGENT ARTHROTOMY.

As a rule, for the purpose of evacuating an articular effusion, whatever its nature may be, an arthrotomy—that is, a short lateral incision into the joint—is better than any puncture ; still, puncture—of the knee usually—is sometimes very useful in cases of recent hæmarthrosis or large serous or sero-sanguineous effusions.

Of course the usual aseptic precautions must be observed before a puncture, just as scrupulously as if an incision was to be made ; the whole region must be washed with soap and water, ether, and alcohol ; the trocar and cannula or the needle will be properly sterilized.

Take the upper and outer angle of the patella as the guide (*Fig.* 519) ; a little above it, and to the outer side, thrust the point of the needle or trocar boldly from without inwards into the synovial cavity below the quadriceps ; remember that the fibrous layers which have to be traversed are fairly resistant, but at the level indicated there is nothing to fear, no vessel to be wounded, and the point may be introduced to a depth of an inch or an inch and a half until the fluid is reached. The flow will be assisted by gentle, steady pressure on the knee. When the joint is empty,

the skin will be pinched around the instrument, which will then be withdrawn by a sharp movement. The puncture will be covered at once with a piece of sterile gauze and a compressive dressing applied.

Every suppurative arthritis ought to be treated by incision, irrigation, and drainage of the joint. This procedure is necessary, not only for the purpose of checking the development of the general septic complications, but also to minimize the local lesions and to save what can be saved of the functional usefulness of the joint. It is of course only a special application of the universal surgical law; to open the articular

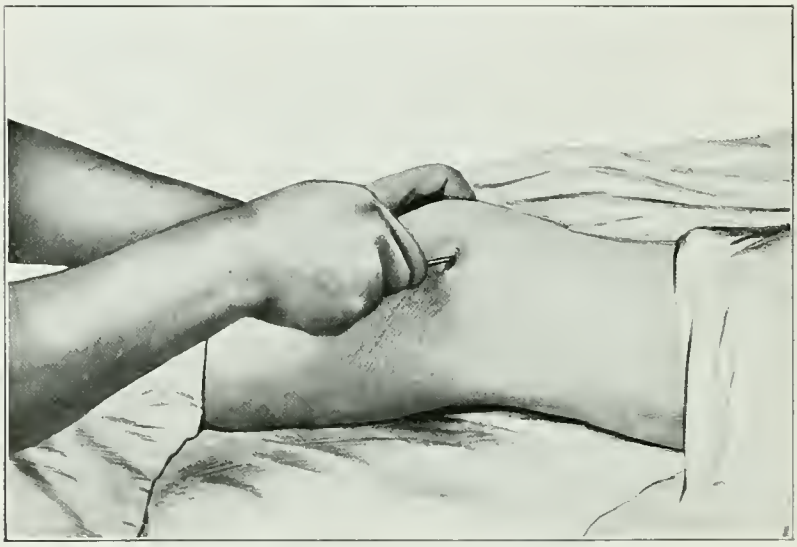

Fig. 519.—Puncture of the knee.

abscess as soon as possible, and to drain it in the best possible manner, are the two essential indications.

These indications present themselves, as we have just seen, in the cases of suppurative traumatic arthritis. Besides this variety, there are others which arise independently of any injury: the pyarthroses associated with puerperal fever, those which occur during the course of or after typhoid fever or the eruptive fevers, especially scarlet fever, pneumonia, erysipelas, etc. Lastly, a place must be reserved for the joint suppurations associated with osteomyelitis, to which we shall return later.

The indications for arthrotomy are not limited to these cases of articular suppuration; without going into details, we may mention the good results which it gives, if performed early, in gonococcal arthritis, in some acute joint inflammations with large effusion, and in traumatic hæmarthroses, such, for example, as those which follow a twist of the knee.

It is on the knee that arthrotomy is most often performed. The technique is as follows :—

I presume that we have to deal with a suppurative arthritis of puerperal origin which has supervened during the first two weeks after the confinement. The knee is swollen, globular, and fluctuating, the skin over it moderately reddened and somewhat œdematous ; it is extremely painful, the least examination or the slightest jolt causes intense suffering ; the temperature oscillates between 101° and 104°, the pulse is fast, the tongue dry, and the general condition bad.

Hasten to open the knee ; remember the dangers of local diffusion, of metastatic abscesses, and of impending pyæmia. Open the joint at once ; the instruments required are few and simple : a scalpel, some pressure-forceps, drainage tubing, an irrigator, that is all.

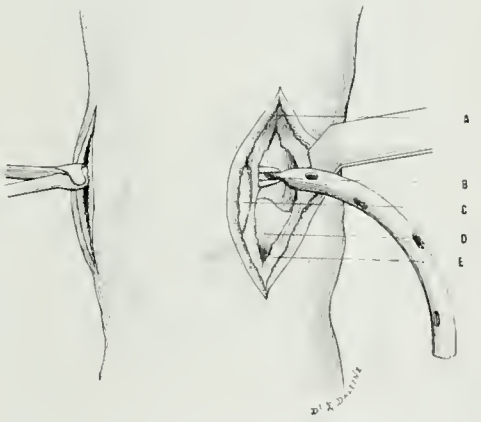

Fig 520.—Arthrotomy of the knee. Passing the drainage tube across the joint. (A) Lower border of the vastus internus divided by the incision. (B) Drainage tube seized with forceps and about to be drawn through from within outwards. (C) Border of the patella. (D) Articular surface of the femoral condyle. (E) Lateral aponeurosis divided.

Employ general or local anæsthesia, with the usual aseptic preparation of the whole surface of the knee, the lower third of the thigh, and the upper third of the leg.

Two longitudinal lateral incisions will be made, one on either side of the joint between the margin of the patella and the condyle ; they will extend from the level of the apex of the patella to well above its base, to give free access to the suprapatellar pouch. When thus placed, the incisions involve no important structure ; there is nothing to fear, and they can be made boldly right down to the pus. They will pass through the skin, the often-infiltrated subcutaneous tissue, and the lateral aponeuroses at the sides of the patella ; above, the knife will cut into the lower borders of the two vasti, especially the vastus internus. Carry the incision without hesitation well into the muscular fibres ; the large vessels are at a safe distance, four inches above the condyle ; some muscular arteries will almost always be cut, but they need only be caught and twisted.

In ordinary conditions there is no need to exaggerate the length of the lateral incisions in an upward direction ; the essential point is to provide free access to the upper cul-de-sac of the joint cavity, so as to ensure adequate cleansing and good drainage.

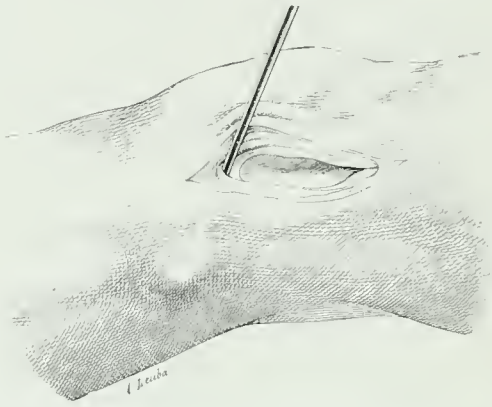

Fig. 521.—Arthrotomy of the knee. Postero-lateral drainage incision : the tip of the director is made to project under the skin at the point where the incision is to be made.

All this can be done very quickly : two long cuts with the knife, and the pus escapes in streams.

Then proceed carefully to cleanse the joint cavity ; wash out all its recesses with very warm boiled salt solution ; evacuate the flakes of purulent lymph and false membrane, and complete the cleansing with gauze swabs held in forceps.

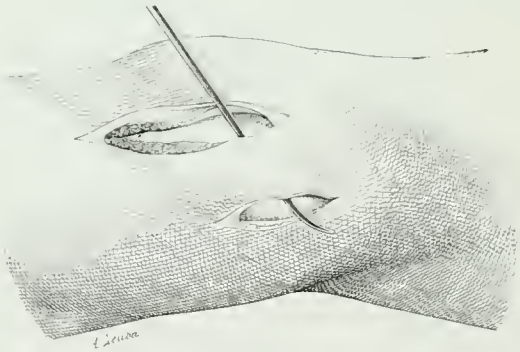

Fig. 522.—Arthrotomy of the knee. Postero-lateral drainage incision : the tube will be passed from one wound to the other.

This thorough washing with boiled water and wiping with sterile gauze is very much better than irrigation with any antiseptic fluids. Still it may be well, especially in the very septic cases, to complete the cleansing

by irrigation with solution of hydrogen peroxide or by swabbing the cavity with a 10 per cent solution of zinc chloride.

Drain the cavity with a large tube passed transversely through the upper part of the joint, as shown in *Fig.* 520, or by means of a tube at either side passed right to the upper part of the suprapatellar pouch and brought out at the middle of the corresponding incision. For the sake of more perfect drainage, it will often be well to make two posterior counter-openings at the bottoms of the lateral recesses ; with this object, a director or a pressure-forceps is introduced at the lower angle of the lateral incision and passed backwards, inside the corresponding lateral ligament, and its tip made to project at the border of the popliteal space. On the outer side the tip of the instrument is made to project in front of the easily

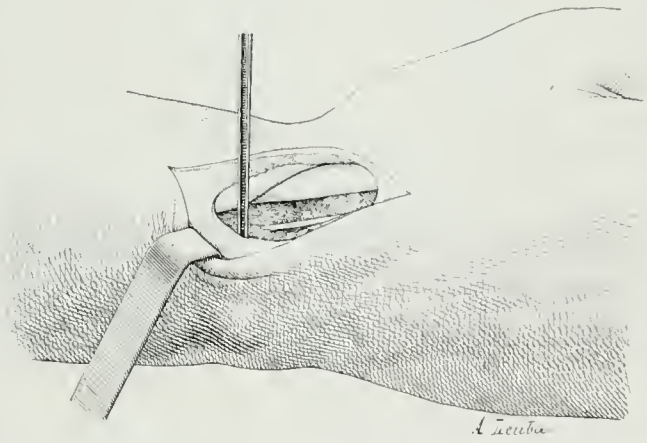

Fig. 523.—Arthrotomy of the wrist. External dorsal incision between the tendons of the long extensor of the thumb and the long radial extensor of the wrist and the extensor tendons of the index finger : a director is passed from without inwards under the bundle of extensor tendons, and made to project under the skin at the point where the internal incision will be made, behind the tendon of the flexor carpi ulnaris.

recognizable tendon of the biceps, in order to avoid the external popliteal nerve ; on the inner side, between the sartorius and gracilis in front and the semi-tendinous and semi-membranosus behind. An incision is made over the projecting tip (*Fig.* 521), and a drainage tube drawn through from one opening to the other (*Fig.* 522).

Leave everything widely open ; envelop the knee in a large, well-padded moist dressing, and immobilize the limb at once in a plaster gutter extending from mid-thigh to mid-leg, and cut away on either side opposite the joint to facilitate the subsequent dressings.

If the temperature falls, and the pain ceases, do not be in a hurry to interfere with the first dressing, and do not irrigate the joint cavity. The drainage tubes will be shortened and removed one by one, as circumstances permit, but not too soon. And lastly, the joint will be kept fixed for as short a time as possible.

At the other joints it is more difficult to provide free access and adequate drainage. A drainage arthrotomy, to be efficient, always necessitates two incisions at least.

The hip-joint will be opened by an incision extending from the apex of the great trochanter to the posterior superior iliac spine ; the gluteus maximus is split in the line of its fibres, the adjacent borders of the gluteus medius and the pyramidalis are separated, and the capsule of the joint incised longitudinally. This is Langenbeck's incision (*Fig.* 524).

It is also possible to reach the joint from the front and from the inner side.

In front, the incision begins a little below Poupart's ligament, and follows the inner border of the sartorius ; the muscle is retracted outwards

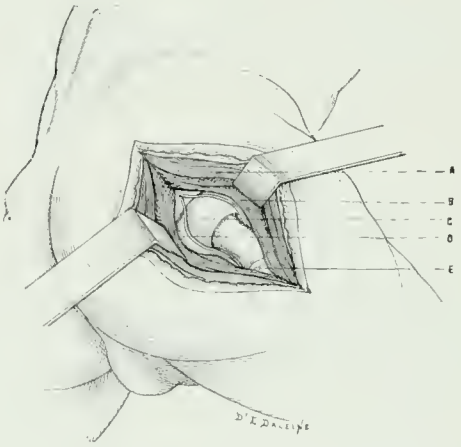

Fig. 524.—Ways of approach to the hip : posterior incision. (A) Gluteus maximus divided. (B) Gluteus medius divided. (C) Head of the femur. (D) Capsule of the joint. (E) Great trochanter.

and the vessels inwards ; the psoas is exposed, its external border freed and retracted inwards. It then only remains to open the capsule (*Fig.* 525).

The internal incision starts at the genito-crural fold, and descends along the middle of the inner surface of the thigh, which is kept in a position of abduction ; it passes between the gracilis and the adductor magnus, as shown in *Fig.* 526.

At the ankle, the incisions are made in front of the malleoli, and the whole bundle of anterior tendons is raised to allow the drainage tubes to be slipped underneath.

At the elbow, the joint cavity is most accessible by way of the lateral grooves at either side of the olecranon ; the incisions will be made longitudinally in those positions. The ulnar nerve, situated behind the inner condyle, must be kept in mind.

At the wrist, make an external incision, oblique downwards and outwards, between the long extensor tendon of the thumb and the extensor

tendons of the index finger (*Fig.* 523). The double prominence formed by these tendons is always quite evident ; the radial artery lies in the line of the incision in the depths of the wound in contact with the bone. Then

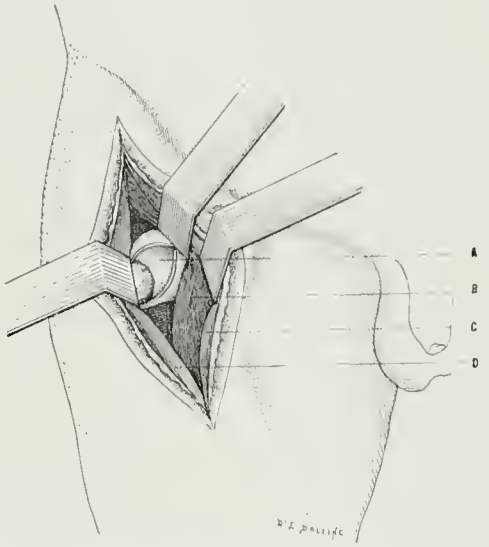

Fig. 525. Ways of approach to the hip : anterior incision. (A) Head of the femur. (B) Ilio-psoas muscle. (C) Rectus muscle drawn inwards. (D) Sartorius, drawn outwards.

make an internal incision, longitudinal, over the inner border of the wrist, between the tendons of the extensor and flexor carpi ulnaris.

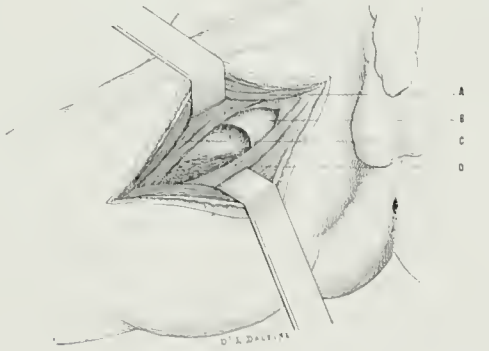

Fig. 526.—Ways of approach to the hip : internal incision. (A) Gracilis drawn forwards. (B) Head of the femur. (C) Adductor brevis. (D) Adductor magnus.

At the shoulder, an anterior vertical incision starting at the tip of the acromion exposes the bicipital groove, and by opening the synovial prolongation situated there, allows the joint cavity to be reached. Better

access is given by a posterior incision ; it begins at the acromial angle and follows the posterior border of the deltoid for a length of two or three inches, and opens into the sub-acromio-deltoid bursa. The two lips of the wound being well retracted, the capsule of the joint, thickened by the tendons of the infraspinatus and teres minor, comes into view and is incised longitudinally.

We must again repeat the statement already made, that in some cases of joint suppuration, arthrotomy is not sufficient for the provision of adequate drainage, and **resection** then becomes necessary. (See *page* 541).

ACUTE OSTEOMYELITIS.

The following case may be quoted as an example :—

Case 37.—A lad, 16 years old, after a fatiguing bicycle race, was suddenly seized with acute pains in the right thigh and knee : he had repeated shivers, fever (102°, 103°), profuse sweating, and could not sleep. The knee swelled rapidly, and attention was at first concentrated on the articular condition, which was supposed to be a rheumatic arthritis. Meanwhile the temperature remained continuously elevated, the pain became intolerable, and when we saw the patient some days later the pulse was rapid and feeble, the tongue dry, the face pinched and wan, and the general condition exceedingly alarming.

An examination of the knee and thigh was very difficult, as the slightest touch caused intense suffering and made the boy cry out. The lower third of the thigh was swollen in its entire circumference ; the swelling, which contrasted markedly with the rest of the limb, extended to the knee, which also quite evidently contained a large quantity of fluid. The skin in the whole of this area had remained white and was marbled with bluish veins.

By careful and gentle examination, the left hand encircling the front of the thigh at the upper limits of the swelling, and the right hand exercising light pressure lower down over the internal condyle, the presence of deep fluctuation and a large fluid accumulation was detected ; pressure on the knee caused no transmission of the fluctuation, and repeated examination failed to discover any continuity between the articular and the peri-femoral accumulations. Further, the palpation was much less painful over the joint. The seat of maximum pain was discovered on the inner aspect of the thigh, about three inches above the knee ; the tenderness at that point was intense, and one naturally refrained from repeating the examination.

The diagnosis was evidently acute suppurative osteomyelitis of the lower end of the femur, and immediate operation was imperative. A long incision was made on the antero-internal aspect of the thigh over the fluctuating swelling. I cut through the skin, the infiltrated subcutaneous tissue, a thick layer of muscle—the vastus internus—and opened into a large sub-periosteal abscess. The cavity extended in front and behind around the femur, which was completely denuded in its lower third, and particularly over the entire extent of its popliteal surface.

With gouge and mallet a deep groove was cut along the inner face of the rough, bare, and reddened bone ; the medullary canal was opened : a purulent stream escaped, mixed with small fragments of spongy bone ; the marrow was infiltrated with pus to a considerable height. The opening in the bone was enlarged upwards, and the whole of the corresponding segment of the medullary canal was curetted.

There was no communication between the knee-joint and the focus of osteomyelitis.

Drainage was provided by means of three large tubes, and the whole wound was left widely open.

The operation was followed by a rapid fall of temperature; the general symptoms subsided, and all danger disappeared, but a huge wound remained, to fill up more or less quickly. Healing was rapid; but a small sinus persisted, leading down to bare bone. Four months later I resected the whole of the sequestrum, and complete and lasting healing followed.

The above is a typical case: the age of the patient, the sudden onset after severe exertion, the high fever and the alarming initial symptoms, the excessive pain situated in the immediate vicinity of the epiphysis of the bone, the swelling involving the entire circumference of the limb, the deep fluctuation, the effusion into the neighbouring joint: all the features in the clinical picture were present, clearly defined and perfectly characteristic in their combination.

The urgent need for operation is indisputable, especially in these grave forms; it is a question of life, and also of saving the limb.

The deep-seated subperiosteal abscess must be opened without delaying until it has separated or destroyed the overlying soft tissues and appears under the skin; for that reason it is essential to know how to seek for and recognize deep fluctuation.

Lastly, simple incision of the subperiosteal abscess is insufficient; as Lannelongue long ago demonstrated, the operation is incomplete —and often useless—if it goes no further. **There are two foci of suppuration in these cases of osteomyelitis: a subperiosteal, peri-epiphyseal focus, and a medullary, intra-osteal focus. It is absolutely necessary to open both foci, and the operation for osteomyelitis consists essentially in opening the affected bone.**

Make a long incision on the side of the limb where the swelling is most marked and where no important structures are situated: at the inner surface of the femur in the supracondyloid zone below the level of Hunter's ring (the opening in the adductor magnus); at the outer surface of the upper part of the humerus, etc. Incise the successive planes layer by layer, skin, fascia, muscles; the abscess lies right at the bottom in contact with the bone. Open it widely, to its extreme upper and lower limits, empty it, and cleanse the cavity and all its diverticula. This is the first step (*Fig.* 527).

Beware of stopping there and of allowing oneself to be influenced by the appearance of the denuded bone. Sometimes, undoubtedly, no opening, no purulent track will be seen in the bare, reddened compact outer layer; but it should be taken as certain that *under the cortex of the bone there is pus*, and without further delay an opening must be made in the bone for the purpose of evacuating it.

In these typical forms which we are at present considering, it is *the bulb of the bone* which must be opened: in other words, the enlarged terminal portion of the diaphysis which adjoins the epiphyseal cartilage. To make the opening, a small crown trephine may be used, if at hand,

or a burr, or even a large drill, but a gouge and mallet will answer perfectly.

In children the bone can be quite easily cut away with a gouge used with the hand alone; do not depend on that, however, and particularly when operating on an adolescent one must expect to find a dense and hard outer layer.

The instrument must penetrate the entire thickness of the wall of the bone, and the task cannot be considered as complete until the reddened, friable, cancellous tissue, infiltrated with pus, has been reached.

There can be no half-measures; we must repeat again what we have had occasion to say before in relation to other conditions, that so long as

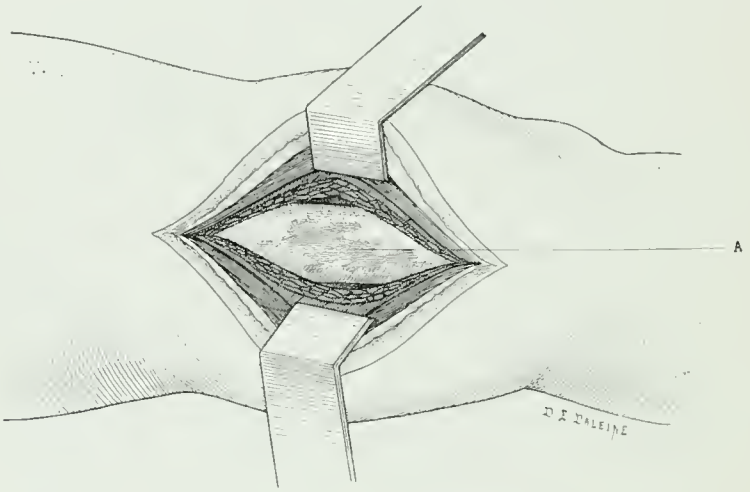

Fig. 527.—Operation for osteomyelitis. First step: incision of the periosteal abscess. (A) The denuded and reddened bone.

there is any doubt, it is certain the desired object has not been attained: in other words, the surgeon has not reached the centre of the bulb, the medullary canal of the bone.

Make at least two openings, one at the centre of the bulb, the other a little higher up in the shaft; if pus is found, do not rest content with the two separate channels, but unite them with the chisel and mallet, cutting a deep groove from the one to the other (*Fig.* 528).

Do not hesitate to make a very extensive opening, nor to cut away a good deal of the cortex of the bone; then with a large, sharp spoon scrape away the infiltrated contents of the affected medullary zone, until healthy tissue which bleeds under the instrument is reached. The freedom from after complications and rapidity of healing will to a great extent depend on the thoroughness with which this step is carried out, and the adequacy of the intra-osseous drainage.

Of course the wound will be left widely open; drainage tubes will be placed in the gap in the bone, and in all the recesses of the abscess cavity,

the rest of which will be lightly packed and the wound dressed with aseptic gauze.

Besides this typical form, there are other and more benign varieties, and others also of extreme gravity in which quite different operative procedures are needed. Although it may sometimes be sufficient, in mild cases seen comparatively early, simply to incise the periosteal abscess, I do not think it worth while opening up anew this old and much disputed question; practically it will be the wisest course, even in the mild forms, **always to open the denuded bone**; even if no pus should be found, the opening and the resulting drainage will never be useless.

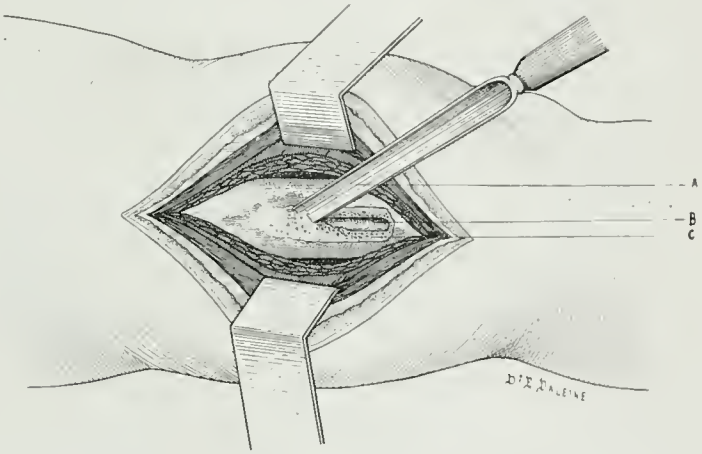

Fig. 528.—Operation for osteomyelitis. Second step: Cutting into the bulb of the bone with gouge and mallet. (A) Gouge cutting a groove. (B) Medulla infiltrated with pus. (C) Compact bone.

Sometimes the suppuration is not limited to the osteomyelitic focus; there is, in contact or in continuity with it, **a purulent arthritis** of the knee, the shoulder, the hip, etc.

In the case which we related at the beginning, we had detected a large effusion into the knee; it was a serous effusion, expressing the reaction of the joint to the neighbouring inflammation. In such circumstances there is nothing to be done, and during the course of the operation care must be exercised to avoid opening the synovial cavity, which is still free from infection; the effusion will be absorbed spontaneously when the osteomyelitic process subsides.

It is a very different matter when the joint is red, œdematous, and very painful, and a pyarthrosis is present. If the joint lesion is independent of the periosteal abscess, arthrotomy, executed in the manner already described, with irrigation and drainage, is necessary and sufficient. But it may be that the articular abscess communicates freely with the intra- and peri-osteal abscess, the suppuration having destroyed the epiphyseal cartilage, invaded the whole epiphysis, and through it the neighbouring

articulation. What is to be done then? By two long lateral incisions open both the articular and bony foci; open up the bulb and the epiphysis, and by means of this large opening try to avoid the necessity for primary total resection, which would hopelessly destroy the growing end of the bone, and would therefore, in young patients, ultimately give rise to very great shortening and serious disability.

In certain forms of extreme malignancy and very rapid evolution, *resection* is unavoidable, at the hip particularly; the epiphysis is separated, infiltrated, and bathed in pus, and a free sacrifice of tissue gives the only chance of saving the limb.

In these hyperacute forms, even in the first days of the illness, **the shaft of the bone may be found bare and necrosed in its entire length**; opening the bone is then useless; the dead diaphysis ought to be removed forthwith. This primary necrosing variety is not uncommon with the short bones, the os calcis in particular; it is advisable to remove the affected bone at once.

Amputation should be only a last resource, which one may be compelled to adopt in some cases of **bipolar osteomyelitis**, where the whole length of the bone is necrosed, the joints above and below suppurating, and the whole limb permeated with purulent tracks. The local conditions are then irremediable, and the danger of septicæmia necessitates the sacrifice of the limb.

ACUTE ABSCESS.—GLANDULAR ABSCESS.—WHITLOW.

A very simple undertaking, very "minor surgery," the opening of an abscess or the incision of a whitlow! Perhaps. But it is a serious matter nevertheless, and one that involves a very considerable responsibility.

I know some patients have died, I know others have been permanently disabled, as a result of minor operations done badly or too late. There are not two degrees of surgery, major and minor; there is one only, that which fulfils the indications in the best and most simple manner and most speedily restores the patient to health.

Every abscess, superficial or deep (and I might add, every abscess of the extremities, of the walls of the trunk, of the viscera), **ought to be opened, emptied, and drained at the earliest possible moment.** That is one of the first laws of practical surgery, and it admits of no exception. Why then, do we still see these enormous accumulations of pus, widely separating skin and muscles, these diffuse abscesses, these obstinate suppurations in which fresh foci are continually appearing, and which are incised again and again, and which require months before healing is complete, and cause permanent and irremediable contractures? Why

should time be lost in waiting for the abscess to localize, or in irrational attempts to "abort" an abscess which is already fluctuating?

In the case of deep suppuration, sub-aponeurotic or intramuscular, fluctuation remains doubtful for a long time; one must know how to test for it, namely, in the direction of the *long axis* of the limb, which is encircled as far as possible by the hands. Do not wait till fluctuation becomes too definite,—in other words, until the pus has become subcutaneous; the steady increase in the size of the swelling, the lancinating pain, the fever, and the subcutaneous œdema are quite sufficiently demonstrative. **Superficial œdema means deep suppuration**; the two conditions are associated; if the first is present, the second may be unhesitatingly diagnosed.

Nor must it be forgotten that in some regions the thickening, the diffuse induration of the skin and subcutaneous tissue, are quite as certain signs of the presence of pus as fluctuation itself. In the nuchal region, on the dorsal aspect of the trunk, and in the hairy scalp, the thick, dense skin, when it becomes œdematous over a deep-seated accumulation of pus, also becomes hard, and this hard œdema is a certain sign of the underlying condition. In the abdominal wall, a deep abscess presents itself as a thick compact mass which sometimes causes one to think of a sarcoma; when the skin pits under the finger, when it becomes œdematous, and when it is even a little reddened, there can be no doubt about the diagnosis.

Incise early and make a free incision.

In the neck and on the head, a small dependent incision, if it is made early and kept open, may suffice for small abscesses; in the case of a large accumulation, particularly if it is deeply situated, the best means of promoting rapid healing and of avoiding an ugly scar is by insuring free drainage from the first.

The whole treatment of acute abscesses may be summarized in two words: **evacuation, drainage.** Nothing more can be done, but that in itself is sufficient. It is hopeless to think of disinfecting the cavity or the walls of an abscess. The abscess is an attenuated, circumscribed focus of infection. Empty it and cleanse it, and the living tissues will do the rest —if their action is not interfered with by the introduction of other microbes.

The practical conclusion is this: the abscess must be opened just as one would treat a clean, fresh wound, **with properly prepared hands, a sterilized knife, and after careful cleansing of the skin.**

Therefore, put aside the old excuse for surgical carelessness: "pus is present, there is no need for cleanliness." Prepare your hands properly, put on gloves (*Fig.* 529), flame-sterilize or boil the knife and the grooved director, wash the affected region carefully with soap and water, with alcohol and boiled water; and then only incise the abscess.

The use of rubber gloves in opening abscesses, and in treating all "dirty" cases, is a practice which ought to be adopted by every one: the gloves figured are of thick rubber, they stand repeated boiling without damage, and in no way interfere with simple manipulations.

The technique is very simple in the case of an abscess which is pointing under the skin. Plunge the point of the knife boldly into the centre of the swelling, then lower the blade to continue the cut longitudinally; do not leave a pocket at the dependent part of the cavity, but carry the incision to and beyond the periphery. If the abscess is very definitely circumscribed, it may be opened by transfixion (*Fig.* 530).

If the cavity is very large and beset with diverticula, and the skin is thin and congested, do not hesitate to extend the incision from one pole to the other, following the long axis, and guard against leaving any floating flap of skin, on the chance of its recovering its vitality and by its presence helping the healing processes. It will simply interfere with the drainage, and a better scar and more rapid healing will be obtained by laying the

Fig. 529.—Putting on long rubber gloves. The right hand glove is filled with boiled water, held vertically, and the hand is insinuated gently into it.

whole area open at once. Allow the pus to escape; then, with a sterile swab or piece of sterile gauze, carefully cleanse the whole cavity, or irrigate it with warm boiled water; to be of any use the irrigation must be thorough, and must wash away all traces of the abscess contents.

If any prolongation or diverticulum is found, it must in its turn be opened up and thoroughly cleared out; if it is dependent and lies below the level of the principal pocket, push the tip of a director to the bottom of the recess, and incise the skin over it. And in similar fashion make as many counter-openings as there are dependent pockets.

A short drainage tube—sterilized, of course—will be placed in each of the counter-openings, and another tube in the principal cavity. If there is an upper diverticulum, the last-mentioned tube will be carried right to the top.

If of sufficient length, in a good dependent position and gaping widely, good drainage will be assured by the incision alone, and the number of drainage tubes which encumber and irritate the wound may be reduced to a minimum. **No gauze should ever be placed in the wound or cavity**; nothing is more illogical than to pack an abscess cavity with gauze.

The dressing should consist of boiled moist compresses, with a thick covering of absorbent and ordinary wool — **and no impermeable tissue**; fix the dressing carefully with the bandage in such a way that it does not slip and expose the wound.

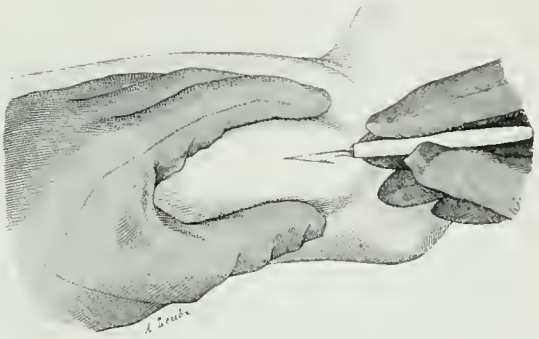

Fig. 530.—Opening a superficial abscess by transfixion.

In the case of **an abscess lying below the deep fascia**, it will be prudent, after having incised the skin with the scalpel, to open up the abscess with the grooved director in the manner we have described elsewhere. (See ABSCESS OF THE NECK.)

A deep-seated submuscular or subperiosteal abscess requires to be *exposed layer by layer, like a tumour*. The skin is incised in the long axis of the swelling, the deep fascia is divided, the muscular layers retracted or cut if necessary, the vessels and nerves being methodically exposed and placed in safety under a retractor until the cavity is reached.

Glandular Abscesses.—In opening these abscesses, some very simple rules must be observed; the proximity of the great vessels need cause no anxiety.

In the axilla, an abscess occupies the inner wall of the space; it is on the inner side, over the thoracic wall, along the lower border of the pectoralis major, that the incision must be made; in that position there is no important vessel (*Fig.* 531), and the operation can be executed boldly, without any danger.

Have the arm abducted from the trunk as far as the pain and the muscular contracture will permit, turn the point of the scalpel inwards, edge downwards, and incise longitudinally the thick, reddened, swelling, which distends the inner part of the axilla.

The vessels are distant, having been carried outwards along with the arm, the back of the knife has been turned towards them, and they cannot be harmed—unless the point of the knife is thrust deeply and blindly right to the apex of the axilla. Some years ago I saw a case of serious ulnar palsy which had resulted from an ill-directed incision; the wound was quite small, and was situated right at the centre of the axillary hollow; the knife, held by a nervous hand, had penetrated vertically from below upwards, and had wounded the nerve.

No such accident is possible if the incision is made in the proper position along the inner wall of the space. The surgeon may therefore go down to the pus at once, or, after having incised the skin, the tissues may be divided

Fig. 531.—Axillary region: the topography of the great vessels.

layer by layer with the knife. If, for any reason, extra caution is desired, incise the skin first of all, and then, by blunt dissection with the director, working towards the chest wall and the lower border of the pectoralis major, open the suppurating cavity (*Fig.* 532).

Do not forget that the abscess wall is sometimes thick, and also that the abscess often extends under the pectoralis major, or that it may be **altogether subpectoral.** In the latter eventuality the inner wall of the axilla is only slightly raised, but by bimanual examination it will be possible to recognize a thick solid mass underlying the anterior wall of the axilla and the front of the chest; frequently it is impossible to get fluctuation in the swelling; the condition is **a large abscess of the thoracic wall.**

The incision must be made along the lower border of the pectoralis major: the muscle border, which is always quite definite, should be clearly

exposed ; the knife is then laid aside and the dissection continued with the director upwards and inwards, while the left hand, applied as in *Fig.* 532, steadies the swelling and presses it outwards. Here, again, care must be taken to make a free opening and to provide good, dependent drainage.

In the groin, a glandular abscess always lies in front of the great vessels ; sometimes the superficial epigastric may be met with in cases of abscesses situated high up, supra-inguinal, or the saphenous vein found lying in front of an abscess near the apex of Scarpa's triangle.

Fig. 532.—Opening a deep sub-pectoral axillary abscess with the grooved director.

With a little care the saphenous can easily be avoided, and if a small arteriole should be cut, a couple of pressure forceps will set matters right.

As a rule, the incision will be made vertically, over the red, fluctuating centre of the swelling. A puncture, or preferably a short dependent incision, may be sufficient in dealing with some buboes, provided that it is made early and that time is not wasted in perfect illusory attempts to " abort " the abscess, while the skin is allowed day by day to become more and more separated, thinned, and irremediably affected.

Whitlow.—I now come to **whitlow**, and **the abscess of the hand** which so often succeeds it. I need scarcely mention the **subcuticular form** ; it is opened with a snip of the scissors, and the whole of the

epidermal covering must be cut away; the red underlying surface should always be carefully examined, and search made for a small opening which sometimes leads down to a deeper accumulation, and which if present must be laid open.

In the case of an ordinary subcutaneous whitlow of one of the intermediate fingers, fluctuation need not be expected and should not be waited for; **fluctuation is never present at the time when the incision ought to be made.** The induration, the dense thickening of the anterior surface, and the œdema of the dorsal aspect of the finger, with the continuous, lancinating, local pain, and the fever, will be sufficient indications of the existence of suppuration.

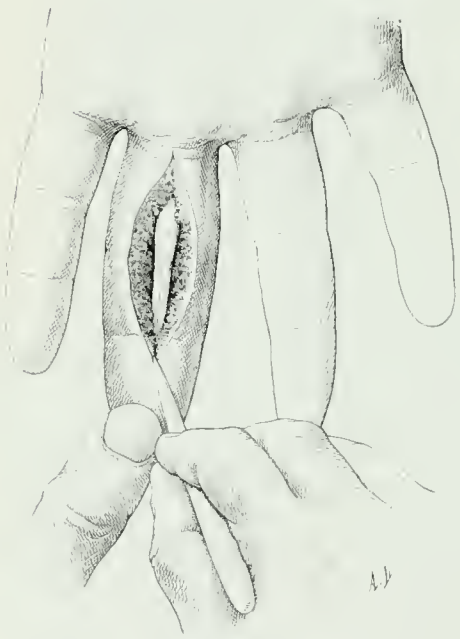

Fig. 533.—Incision of a deep whitlow.

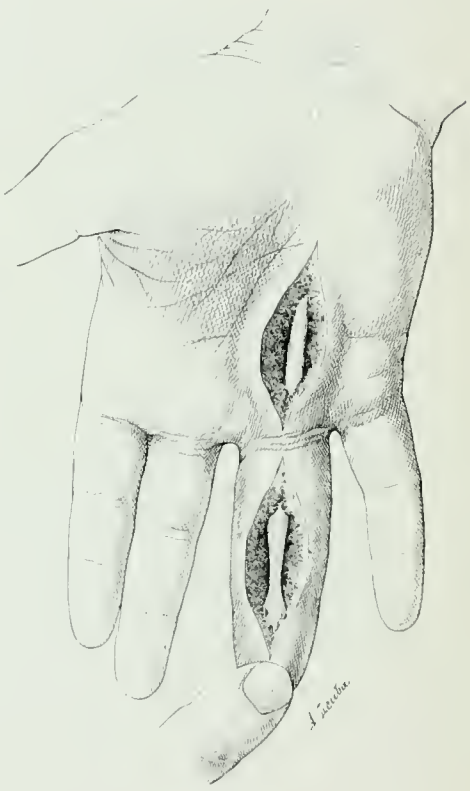

Fig. 534.—Double incision, in the finger and in the palm, of a deep whitlow.

Make the incision longitudinally over the middle of palmar aspect of the affected finger; if the suppurative process is still limited to one of the phalanges, seek for the point or line of maximum pain by pressure with a blunt point, the end of a probe or director, and make the incision accordingly. Above all, never make punctures or timid incisions which scarcely penetrate the skin; remember that the skin and subcutaneous tissue are very thick and tough, and that a considerable effort is required to divide them freely and to make a sufficient opening with a single cut. Regional

anæsthesia by Reclus' "ring" method, already described (see ANÆSTHESIA, Vol. I.) will be found particularly useful in these cases.

If the finger is semi-flexed and cannot be straightened, the tendon sheath is affected; this fact will further be indicated by the intensity of the local pain and the severity of the general symptoms; **the sheath must then be opened**, and the incision must go down to the bone.

The incision must again be made along the mid-line of the finger the collateral arteries are out of danger, and there is nothing to fear. One

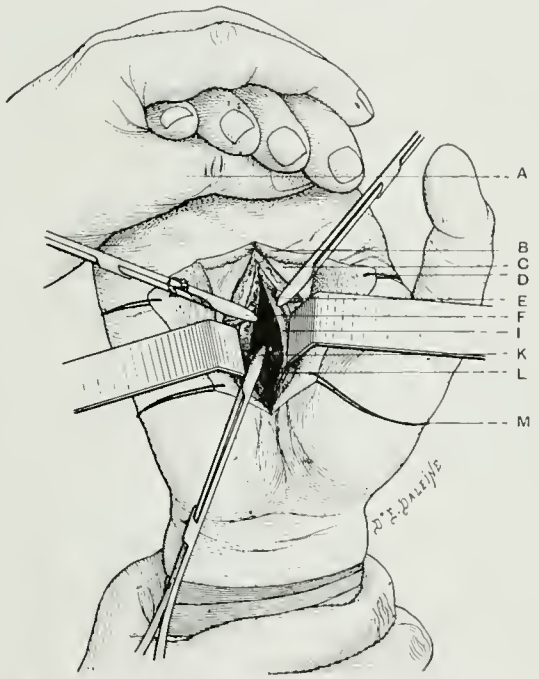

Fig. 535. Checking hæmorrhage from the arteries of the palm. (Compression of the wrist; hand elevated; fingers flexed; retraction of the edges of the wound, which has been enlarged by cutting lateral flaps.) (A) Left hand of the assistant flexing the fingers, while his right hand compresses the wrist. (B) Transverse extension of the lower angle of the wound, permitting the raising of two flaps. (C) Palmar fascia. (D) Retracting thread passed through one of the edges of the wound and knotted behind the hand with the corresponding thread in the opposite edge. (EF) Pressure forceps on the two ends of the cut superficial palmar arch. (I) Tendons. (K) Forceps on deep palmar arch. (L) Inner border of the thenar eminence. (M) Second retracting thread knotted behind the hand.

point only need occupy the attention: to feel the bone under the point of the knife; **this contact with the bone will constitute the deep landmark.** Carry the deep incision along the whole length of the finger (*Fig* 533); combine it, if the whole sheath is affected, with a second incision in the palm above the digito-palmar fold (*Fig.* 534), low enough, however, to avoid wounding the superficial palmar arch (*Fig.* 536).

It may happen, nevertheless, that a badly placed incision involves the palmar arch; it may also happen that the vessels are eroded in badly

drained foci of suppuration in cases of infected wounds. Whether primary or secondary, the resulting **hæmorrhages of the hand** are serious, and necessitate operations which are often troublesome. What follows is to a great extent also applicable to traumatic hæmorrhages resulting from wounds of the palm of the hand.

Endeavour to catch and tie the two cut ends, or rather everything that bleeds, in the wound: that is the principle which must be aimed at, whatever the difficulties in its application. But such a task should never be undertaken in a haphazard fashion. Apply compression above the wrist, and have the hand elevated; enlarge the wound longitudinally at once; have both edges of the wound retracted, or, if assistance is wanting,

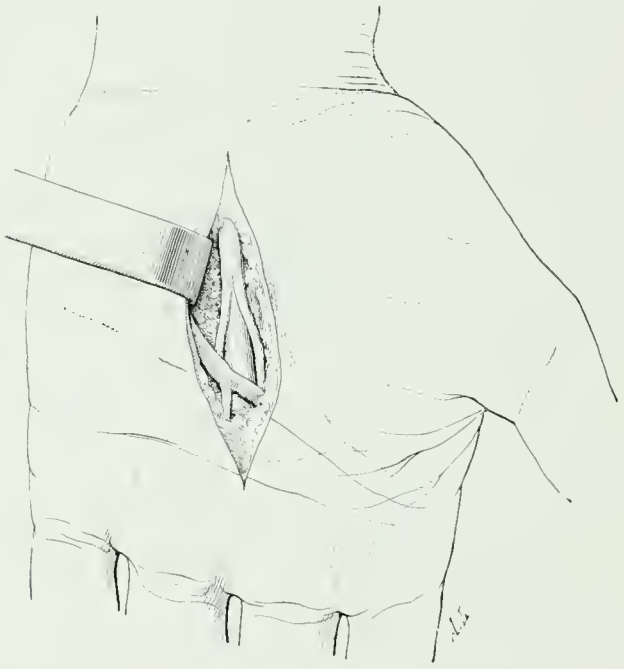

Fig. 536.—Situation of the superficial palmar arch, between the upper and middle cutaneous folds.

pass a suture through each edge and knot them together behind the back of the hand. None of these preliminaries which are necessary for a clear view of the wound should be neglected. Then look for the ends of the wounded arteries and apply forceps to them.

With a recent wound, it will in this manner be possible to seize and ligate the wounded vessels. In an infected wound, when the tissues are softened and friable, the forceps will not hold and the ligatures will tear off; instead of trying to tie over the forceps in the usual way, it will then be necessary to go a little higher up and to pass the ligature with a curved needle around the vessel, including in the grasp of the ligature a small amount of the surrounding tissues, and to tighten it very gently. In some

cases it will be better to leave the forceps on the vessels, and to envelop and support them with layers of aseptic gauze. It would only be in cases where it had been found absolutely impossible to effect hæmostasis directly that recourse would be had to simultaneous ligature of the radial and ulnar arteries at the wrist, or to ligature of the brachial at the bend of the elbow.

Careful disinfection, free exposure and drainage of all recesses, and prolonged baths, are the best means of preventing secondary hæmorrhages or their recurrence.

How many serious and extensive suppurations, how many contractures and permanent infirmities, would be prevented if early and deep incision were the rule in these cases! And the danger is particularly great when it is one of the lateral digits which is affected, **the thumb or the little finger**, the sheaths of which extend above the wrist. Here again, fluctuation must not be waited for; the pain, the retraction of the fingers, the distention of the palm, and the deep-seated swelling of the wrist, indicate only too clearly the presence of ascending suppuration and the need for immediate operation.

The palmar segment of the sheath must be opened, then the upper prolongation will be incised above the wrist; lastly, a drainage tube will be passed from one opening to the other. The operation is often—in certain surroundings—a difficult one, but it is an operation of immediate necessity if the hand is to be saved. General anæsthesia is almost always absolutely necessary.

In the case of **suppuration in the ulnar sheath**, incise first in the palm, in a line with the space between the ring and little fingers, go down to the tendons, and open the abscess freely. Then insinuate a grooved director from below upwards along the cavity to above the level of the annular ligament; make its tip project as prominently as possible a good half inch to the outer side of the tendon of the flexor carpi ulnaris, and cut down on it layer by layer, remembering the median nerve, which lies exactly in the middle line of the wrist, and the ulnar artery to the inner side; push the end of the director through the opening, and extend the incision with the scissors.

If it is **the radial sheath** which is affected, make the incision in the commissure between the thumb and index finger down to the pus; pass the director along the sheath as before, and make its tip present above the annular ligament at the outer border of the flexor carpi radialis, which is easily recognizable in spite of the swelling; it is there, outside and parallel to the tendon, that the upper incision will be made.

It only then remains to slip a drainage tube around the director and to draw it down from one opening to the other by means of a forceps passed up from below, or vice versa, whichever is most convenient.

When the operation is completed, place the limb in a bath and keep it there for some hours, changing the fluid from time to time, to maintain a constant temperature. The continuous bath constitutes the best means of after-treatment in these cases.

DIFFUSE CELLULITIS.—DIFFUSE CARBUNCLE.

The two following cases may be quoted :—

Case 38.—A strong, healthy young man, 24 years of age, a noted football player, during the course of a game received a violent kick on the left shin ; a contused wound was the result, and remained undressed, contaminated with earth, and in contact with wet garments for a considerable time. In spite of the attention which was given to the injury later, the whole region soon became red and swollen, the temperature rose, and some days later when we saw him his condition had become very serious.

The temperature was over 103°, the pulse rapid and poor, the tongue dry and brown, and he looked very ill ; in the daytime he was drowsy, and at night delirious. There was diffuse swelling and redness of the whole of the leg and the lower third of the thigh, the entire circumference of the limb being affected ; here and there the skin was marbled with large purple, blackish, or dirty-yellow patches, and covered with numerous blebs containing brown-coloured serum ; the consistence of the infiltrated area was on the whole soft, semi-fluctuant in some places, tense and almost hard in others, and the wound gave issue to fœtid, sanious fluid mixed with pus. At the upper limit of the infiltrated area there was a deep-red zone, which extended in streaks up the thigh.

The diagnosis and the gravity of the prognosis were only too evident.

The patient was anæsthetized at once, and, on the whole circumference of the limb long incisions were made with the thermo-cautery ; under the skin I passed through a thick greyish-yellow sloughing layer, and at several places I also opened the deep fascia, the dusky, dirty appearance of which indicated the deep diffusion of the infection. At the upper limits of the affected area, and in the intervals between the long incisions, numerous punctures were made with the thermo-cautery, from all of which the same reddish, fœtid fluid escaped.

After this treatment the general symptoms subsided to a considerable extent, and large segments of gangrenous cellular tissue began to separate ; but the appearance of the wounds remained unsatisfactory and the temperature elevated. The limb was therefore irrigated twice daily with solution of peroxide of hydrogen, and in the intervals was enveloped with compresses moistened with the same solution. The result was very striking ; the elimination of the sloughs progressed rapidly, the wound surfaces became covered with healthy granulations, while the general condition improved and the temperature fell steadily.

I need not go into the details of the long history. Two months later the healing processes were well advanced, and I was able to cover a large granulating surface, which occupied the antero-external aspect of the leg, with Thiersch grafts. Healing was completed without any complication, and to-day the functional usefulness of the limb is perfectly normal.

Case 39.—The second example is even more instructive, because the condition was so serious that it seemed almost certain that amputation would be required.

It related to a poor navvy, about 40 years of age, who was brought to the Beaujon Hospital with diffuse gangrenous cellulitis involving the whole of the left lower limb up to mid-thigh. The condition was of some days' standing, and had developed after a superficial crush. The foot, the leg, and the knee were enormously swollen and covered with blackish patches ; the temperature was above 104°, the pulse was very poor ; the earthy colour of the face and the general depression indicated a dangerous degree of septic intoxication.

High amputation of the thigh appeared to be almost the only chance ; however, we wished to make a last attempt to save the limb. Long, deep,

parallel incisions were made in the foot, the leg, and the thigh, with the thermo-cautery, and numerous deep punctures in the intervals between them. After these multiple openings, the limb presented a most unpromising appearance; it was enveloped with gauze soaked in alcohol, and subcutaneous injections of salt solution in large doses were begun.

Here again the condition subsided, and though healing was very slow, the limb was saved and a most unexpected recovery obtained.

One must be acquainted with these terrible forms of diffuse cellulitis —they are comparatively rare nowadays—in order primarily to prevent them, and subsequently to apply the only effectual treatment, that which we are about to describe.

Diffuse cellulitis after certain infected punctures or dirty, contused wounds or compound fractures, etc., can only be prevented by **early and free incisions**—in other words, by insuring the best possible **drainage** of the infected focus.

The advance of diffuse cellulitis, once developed, is only to be arrested by the rigorous, almost ruthless application of the same method. Diffuse cellulitis is not a suppuration; *it is a gangrene*, a diffuse progressive gangrene —without tendency to become localized—of the subcutaneous and deep cellular tissues.

Do not look for a collection of pus, a localized abscess, or diffuse suppuration; do not wait uselessly till suppuration develops; the pus will appear later, with the separation of the sloughs, in other words, when the advance of the diffuse infection has been stayed. It is therefore not a question of opening definitely localized foci, of making incisions at this or the other point; **it is necessary to incise everywhere, and to carry the incisions to the extreme limits of the infected area.**

Do not waste precious time, which is simply of vital importance, in any superficial, illusory measures, such as Dobson's acupuncture, various subcutaneous injections, external applications, or short, timid incisions. One can only save the patient, one can only save the limb, by employing promptly and boldly the following method:—

With the thermo-cautery knife, over the whole area of cellulitis, make longitudinal incisions parallel to the long axis of the limb; do not hesitate to make the incisions five or six inches in length; between them leave bands about three inches wide to obviate the risks of the intermediate bridges sloughing; divide the skin, and underneath it open up the thick, yellow, infiltrated subcutaneous tissues, with long repeated cuts of the cautery blade, until the deep fascia comes into sight, and if the appearance of the latter is bad, if it looks greenish or dirty, incise it also and open up the deep cellular spaces.

Take care not to make the incisions over the lines of the great vessels; in the subcutaneous plane, veins, even large veins like the saphenous, will sometimes be wounded, but the bleeding can always be arrested easily; a little pressure, sometimes a forceps left on the vessel for a few hours, will suffice to effect hæmostasis.

The surgeon must therefore not allow fear of injuring the vessels to prevent him from making—with due precautions—the incisions sufficiently

deep, and from supplementing the drainage by **multiple punctures** in the intervals between the incisions. Make the punctures specially numerous and deep in the zone of diffuse redness and œdema which marks the advancing border of the infective process.

Then place the limb in a bath of simple warm boiled water, without the addition of any antiseptics; the value of these local baths depends essentially on the continuous lavage of the infected tissues. **Keep the limb in the bath for several hours,** renewing the water from time to time or adding fresh quantities, so as to maintain a constant temperature. Afterwards envelop the limb in large sheets of sterile gauze soaked in alcohol or peroxide of hydrogen, covered with a thick layer of wool and without any impermeable tissue.

Solution of peroxide of hydrogen is very specially indicated in the cases of this kind; it is useful both for irrigation of the wounds and as a continuous dressing.[1] The results which it gives in these gangrenous infections are of such a nature as to make it desirable that its use should become much more general. It is the peroxide of hydrogen of 10 or 12 volumes which is commonly employed; it is particularly useful as an irrigating medium, as J. L. Championnière has shown.[1]

By means of these really active and efficient therapeutic measures, it will be possible to deal successfully with even the gravest cases of diffuse cellulitis, provided, however, that the patient's vital powers are not irremediably compromised. **High amputation** will remain as a quite exceptional resource, and also in the circumstances an exceedingly precarious one.

Carbuncles.—The same line of action should be followed in the treatment of **carbuncles,** the gravity of which is scarcely less than that of diffuse cellulitis.

Case 40.—I was called to see a very stout woman, about 50 years of age, who had been suffering with a carbuncle on the back for a week. Moist dressings, various antiseptics, some punctures, and a short incision at a point which seemed fluctuant, had had no effect in retarding the development of the condition; from day to day the patient's general state had become more serious, the fever remained high (103° to 104°), the pulse was bad, respiration difficult, and further—a point which should always be investigated, as the condition is often present—the urine contained a considerable quantity of sugar.

At the middle of the back there was an enormous mass, almost two handsbreadth; its central portion was prominent and convex, and of a dusky red colour; the borders were rounded but not sharply delimitated, and were surrounded by a zone of diffuse redness and œdema which extended laterally to the sides of the trunk and upwards to the root of the neck. The marginal inflammatory zone was, one might say, extending hourly, and the central mass enlarged at the same pace.

It was a rapidly advancing carbuncle, with very grave toxæmia; and speedy death was certain in default of efficient treatment. It was necessary at any cost to check the advance of the infective processes, and free, immediate incision was urgently necessary.

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[1] See J. L. Championnière, *Académie de méd.* 6 déc., 1898.—Thirria, De l'emploi de l'oxygène en chirurgie (eau oxygénée et gaz oxygène). *Bull. de l'Acad. de méd. de Belgique,* 1899.—P. Labrens, *De l'eau oxygénée en chirurgie et en obstétrique.* Thèse de doct., 1899; also discussion at the Soc. de Chir., 30 janvier, 1900.

The patient was anæsthetized. The enormous swelling was split with the thermo-cautery from top to bottom, and from side to side, *in both directions through its entire thickness right down to the deep fascia*. The knife cut through a dense mass nearly four inches in thickness, consisting of sloughs, fragments of greyish and gangrenous tissue, interspersed with purulent vacuoles; large masses of the gangrenous tissue were excised, and the huge infected focus cleared out as far as possible, the cautery incisions being carried well into the advancing border. The area was freely irrigated and a large moist dressing applied. Here again, though healing took a long time, the operation was followed by recovery.

There should be no hesitation in treating in this way any large carbuncles of the back, the nuchal region, the face, or the limbs, which have not well-defined borders and which tend steadily to increase; the surrounding red, thickened, and œdematous zone is there to indicate the advancing infection, even when the general symptoms are not very alarming.

Open up the mass longitudinally and transversely with the thermo-cautery; if necessary, if the carbuncle is very large, make a series of radiating incisions from the centre to the periphery. The incisions must be deep, must go down to the deep fascia, must extend widely beyond the border of the carbuncle proper, and must drain the surrounding zone of advancing infection.

Evacuate the pus and the sloughs, excise as much as possible of the "carbuncle tissue," lay the whole area widely open, and insure perfect drainage. Here again, peroxide of hydrogen is extremely useful, and also prolonged spraying with boiled water; under the influence of these agents the appearance of the wounds rapidly improves, and the separation of sloughs and the formation of healthy granulations are hastened.

On the face, and especially the upper lip, a carbuncle, even when small, is always dangerous, and very early incision with the thermo-cautery is a necessary precaution; of course, in the diffuse forms, with considerable œdema and impending danger of phlebitis, free incision becomes imperative.

ANTHRAX.

I shall merely indicate the general lines of immediate treatment in cases of **malignant pustule** and **diffuse anthrax œdema**.

Immediate treatment is the proper expression, for here again time is an essential factor in the success of any therapeutic measures. And early treatment depends on an early diagnosis. In some countries where anthrax is common, experience is speedily acquired, and practitioners are on the look-out for the first indications of inoculation, and consequently recognize the malignant pustule in its very early stages; this early recognition is a very important factor, and undoubtedly explains the successful results which have attended very diverse methods of treatment.

Once fully developed, a malignant pustule presents a very typical appearance: the central black slough, the circle of small vesicles, the red inflammatory areola, the more or less extensive peripheral zone of œdema, in regular and concentric succession, are unmistakable in recent and typical cases. The occupation and habitat of the patient are also important

diagnostic elements. At one time, at the Cochin Hospital and at La Pitié, I saw a fairly large number of cases of anthrax, and I can say that even when the local lesions were somewhat indefinite and atypical, the diagnosis was always made without very much difficulty.

How is a malignant pustule to be treated? **The thermo-cautery** and **tincture of iodine**; these are the two principal therapeutic agents.

With the cautery knife at a red heat, split the central slough to beyond the ring of vesicles, then excise the two halves one after the other. Or, better still, make a circular incision with the cautery half an inch from the margin of the pustule, and excise the mass in one piece; cauterize the bottom of the wound boldly, and all around make numerous deep punctures through the whole thickness of the skin into the underlying tissues. At the same sitting give a first series of iodine injections into the surrounding œdematous zone; use a solution of 1 in 200, or even the pure tincture. With an ordinary hypodermic syringe and needle make four, six, ten, or twelve circumferential punctures on one or two concentric lines around the central focus, which has just been cauterized or excised, and at each spot inject slowly 8 or 10 minims of the $\frac{1}{2}$ per cent solution, 2, 3, or 4 minims of the pure tincture.

Some hours later, if the œdema has extended, the injections will be repeated a little further out, and for two, three or four days, if necessary, the work of circumscribing the infective process will be continued in this manner, morning and evening.

These measures will suffice in recent cases of average malignancy. If the œdema increases very rapidly, and if the margins of the excised zone become black and gangrenous, or if, again, when first seen, the pustule is already very large, with widespread diffuse swelling, the chief reliance should be placed in **the thermo-cautery** used in the same way *as when dealing with a case of diffuse cellulitis*. Lay the œdematous zone open from one border to the other; make a series of deep radiating incisions, and, in the intervals, numerous deep perforations, with the thermo-cautery point.

The latter method of treatment is applicable as a primary measure to cases of **diffuse anthrax œdema**, which usually appears first as a soft, indolent, transparent swelling of the eyelids, and spreads very quickly, assuming enormous proportions. There is no time to lose in these extremely malignant forms, and free, immediate incisions with the red iron are far more efficacious than any injections.

At the present day our treatment can go no further; the anti-anthrax serum is of too little value to be generally employed. And indeed, when general infection has occurred, the efficacy of any treatment is very doubtful.

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